A TEXT-BOOK FOR TRAINING SCHOOLS FOR NURSES

A TEXT-BOOK FOR
TRAINING SCHOOLS FOR NURSES

INCLUDING

PHYSIOLOGY AND HYGIENE

AND THE

PRINCIPLES AND PRACTICE OF NURSING

BY

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WITH AN INTRODUCTION BY

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IN TWO VOLUMES

VOL. I.

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Dedicated to

DR. EDWARD COWLES

Whose Effort toward the Perfection of
Training School Methods in the Boston City Hospital
and Later in the McLean Hospital
has Been a Chief Factor
in the Advancement of Training Schools
for Nurses
During the Last Two Decades

"The nursing art, like the healing art, is an act of mercy—in itself too essentially noble to inquire whether the misery that it relieves merits help."—WILKIE COLLINS.

INTRODUCTION.

The modern training of nurses in the care of persons suffering with mental disorders is so new that there are still no proper text-books covering methodically the field of required study. It is not to be regretted that this has been so until now, for it is only by experience that we have learned what is needed.

Only ten years ago the first qualified nurses, trained in organized schools, were enabled to offer themselves as proficient in the care of mental cases in the hospitals and in private homes. It is well that the text-books of the general hospital schools have been relied upon almost wholly in this formative period of our work. Knowledge of general nursing, a "bodily nursing" as it has been called, as related to general medicine is the essential foundation of mental nursing. Any course of teaching that omits a thorough grounding of the nurse in such general principles would be as fatal to her success as a like limitation to that of the specialist physician. It is that omission which has delayed the lunacy reform of the century until the last decade in its recognition of a truth that has made possible as many as forty American schools, which are now in active operation in our hospitals for the insane.

One of the earliest workers in this field now presents in this manual the results of his experience and careful labors in the teaching of nurses in the care of his own

patients. The aim of the work being to fill the entire need of a text-book, without auxiliary books, in the training schools of our special hospitals, the vital principle is regarded in the concise teaching of what the nurse should know of anatomy, physiology, and hygiene, noting the special relations of these subjects to the treatment of the insane. It is consistent with the guiding principle that instruction in the practice of the art of nursing should follow in the second volume, and that mental illness should be treated as a sequence of bodily disorders. The division of the two volumes into thirty chapters each is well calculated to furnish a graded course of recitations to fill the usual school terms of two years.

The plan of the work will commend itself to teachers as affording, in a progressive and logical manner, the basis of a course of study to which should be added the collateral instruction which can be given in lectures, clinical demonstrations, and practical drill in all the manipulations of nursing.

Such a manual as this has been waited for long and wisely; it is a cause for congratulation that so welcome a contribution now comes to the aid of a great medical reform. This reform in nursing the insane, in its extension beyond the most sanguine expectations, is one that not only begets enthusiastic interest in itself, on the part of those who join in it, but it arouses also the progressive spirit in regard to all that pertains to the advancement of psychiatry.

EDWARD COWLES.

MCLEAN HOSPITAL, July, 1896.

PREFACE.

THE purpose of the following volumes is, briefly stated, to provide a text-book that will suffice for all the recitations in a two years' course in training schools for nurses. It will furnish a basis for the usual curriculum, and an endeavor has been made to treat every subject taught by recitation impartially.

The division by chapters contemplates the division of the year by recitations. Hence, a recitation weekly will provide for thirty in the usual school year. The length of the recitations has been determined by experience. Didactic teaching is emphasized, anticipating that details and the practical application of methods, or matters that require manipulation by the student, will be provided for by clinical and bedside teaching.

Three methods of teaching are practised in the modern training school, viz., recitations, lectures, and bedside or clinical teaching. The present volumes are intended as a text for the first class of training-school work, without other aid than that supplied by the teacher. The course adopted is based upon the hypothesis that a nurse must understand the fundamental principles of physiology and hygiene before a rational understanding of the principles of nursing is possible. The first volume, or first year's course, is therefore largely preparatory; the principles and practice of

nursing being provided for in the second volume, or senior year of the course. This is in accord with the graded course now generally adopted in medical schools.

An effort of the writer has been to keep as near as possible to the neutral line between medicine and nursing. As long as the nurse is confined to a two years' course, it is impracticable to require a systematic knowledge of anatomy, physiology, and materia medica; but a general knowledge of bodily organization and function is necessary in order to comprehend many requirements of nursing. The difficulty lies, therefore, in either teaching too little or too much of the technical branches. It is to be hoped that in these volumes the middle line has been successfully reached.

The author desires to acknowledge the assistance rendered by Dr. Caroline S. Pease, in the preparation of the chapters upon obstetrics and gynæcology; also, the gracious assistance of his colleagues, particularly Drs. R. H. Hutchings and W. L. Babcock, and Miss L. E. Miller, in the correction of proof and in the preparation of copy.

For students who desire to supplement their library, the following list of reference books is given: *Physiology and Hygiene*, Hutchinson; *Text-Book of Nursing*, Weeks-Shaw; *The Care of the Sick*, Dr. Th. Billroth; *Principles and Practice of Nursing*, Isabel A. Hampton; *Manual of Nursing*, Humphrey; *Hand-Book for Hospitals*, State Charities Aid Association; *Manual for Monthly Nurses*, Cullingworth; *Accidental Injuries*, Cantlie; *Text-Book on Nursing*, Phelps; *Emergencies*, Dulles; *Obstetrical Nursing*, Parvin; *Massage and the Swedish Movements*, Ostrom; *Notes on Nursing*, Night-

ingale; *Duties of Hospital Sisters*, Eva Luckes; *Hand-Book of Invalid Cooking*, Boland; *Manual for Hospital Nurses*, Domville; *How to Care for the Insane*, Granger; *Primer of Psychology and Mental Diseases*, Burr; *Surgical Nursing*, Voswinkle; *Hygiene of the Nursery*, Starr; *Massage for Nurses*, Goldsmith; *Nursing in Abdominal Surgery*, Fullerton; *Materia Medica for Nurses*, Dock.

OGDENSBURG, N. Y.,
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A TEXT-BOOK FOR

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CHAPTER I.

BONES.

THE study of the human body is termed *Human Anatomy*, and that of the bodily functions, *Human Physiology*.

The *Human Skeleton* (Fig. 1) is the framework of the body, and is composed of 200 distinct bones. The purpose of this unyielding frame is to support and protect the soft tissues. Bones are divided into four classes: Long, Short, Flat, and Irregular. They form three great cavities—the skull, the chest, and the pelvis—which contain the vital organs of the body.

Structure of the Bones.—On examining a section of bone, it is seen to be composed of two kinds of tissue, one of which is dense, like ivory, and the other consisting of fibres, or cancellous. The hard tissue is placed upon the outside. Bone is enclosed in a tough membrane (the *periosteum*). It is through the periosteum that the blood-vessels chiefly reach the bone. In young bones, it is thick and very vascular (full of blood-vessels). Later in life, it is thinner and more closely connected to the bone. If the periosteum is

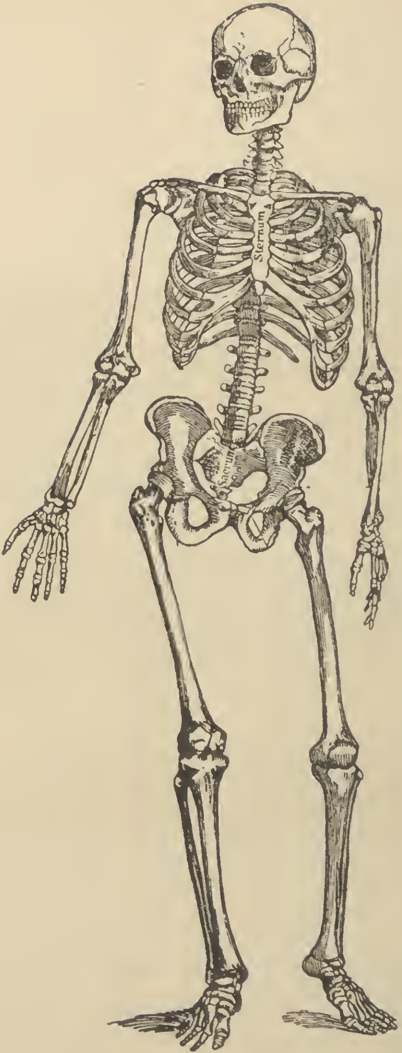

FIG. 1.—THE SKELETON.

removed or injured so as to disturb the supply of blood (nutrition) to the bone, it is liable to necrosis (death). There is a cavity through the centre of long bones filled with marrow, which is a tissue largely composed of fat. The blood-vessels of bones are very numerous.

FIG. 2.—SHOWING THE CANCELLOUS STRUCTURE OF THE THIGH BONE.

Composition of the Bones.—The bones are composed of mineral (inorganic) and animal (organic) matter—about two parts of the former to one of the latter. The mineral matter gives hardness and the animal matter

elasticity and toughness to the bones. By exposing the bone to great heat, the animal matter is driven off, and this leaves the bone very brittle. If the bone is soaked in an acid, it dissolves out the mineral matter, leaving the bone very elastic, so that it can bend without breaking. In childhood, there is a greater proportion of animal matter, which makes young bones harder to break.[1] On the other hand, old bones have a smaller proportion of animal matter, which makes them brittle. For the same reason, young bones unite quicker than old ones. There is a disease which softens bones (*mollities ossium*).[2] Bone is also subject to inflammation (osteitis), to ulceration (caries), and to death (necrosis). The last is always due to injury which cuts off the supply of blood.

The long bones of the extremities and the bones of the head contain more mineral matter than those of the trunk. Some of the diseases of bone depend upon the disproportion of mineral and animal matter. In addition to those already stated, a common disease of bones in children (rickets) is the result of defective nutrition, whereby the bone has a reduced amount of earthy matter, while the animal matter is unhealthy.

The *marrow* is now supposed to have some function connected with the purification and enriching of the blood.[3] In young bones, it is a transparent reddish fluid free from fat. In the shafts of adult long bones,

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[1] In children, a fracture of a bone is sometimes partial—that is, broken partly through and the remainder bent. This is due to the larger amount of organic matter in young bones. From its resemblance, it is called "green-stick fracture."

[2] Insane persons are frequently subject to this disease.

[3] Bone marrow is now used in anæmia, a condition characterized by a lack of red blood discs and iron (hæmatin).

it is of a yellow color, and contains 96 per cent. of fat. In flat and short bones, it is of a red color.

The *Skull* (Fig. 3) is composed of 22 bones, divided into the cranium (8 bones) and the face (14 bones). The *Cranium* is substantially one bone, as the several parts are connected by *sutures*, which are rough edges of bone that lock into each other and make an immovable connection. The several bones of the cranium

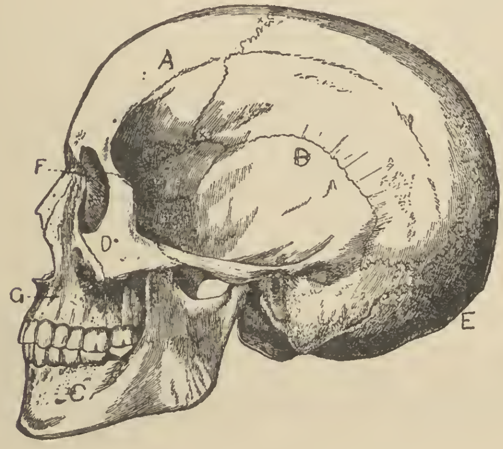

FIG. 3.—LATERAL VIEW OF THE SKULL. A, Frontal Bone; B, Temporal; C, Inferior Maxillary; E, Occipital; F, Orbit; G, Superior Maxillary.

are the *occipital*, which joins the spinal column; 2 *parietal*, which form by their union the sides and roof of the skull; the *frontal*, which resembles a cockle shell in form and which forms the forehead; 2 *temporal*, situated at the side and base of the skull; the *sphenoid*,

resembling a flying bat, situated at the base of the skull, and uniting with all the other bones of the cranium; the *ethmoid*, a light, spongy bone at the root of the nose, and helping to form the two nasal cavities.

The *Fontanelles.*—At birth the bones at the top and sides of the skull are not united, and leave spaces of considerable size, which are called *fontanelles* (Fig. 4).

FIG. 4.—SKULL AT BIRTH, SHOWING FONTANELLES.

There are four of these and two of them can be easily seen in the infant, by the pulsation, and can be plainly felt. The *anterior* (front) is the larger, and is at the junction of the *sagittal* and *coronal* suture. It is the last one to close, and sometimes remains open for more than two years, but usually closes the first year. The *posterior* (back) is smaller, situated at the junction of the *sagittal* and *lambdoid* sutures, and is closed a few months after birth. The two remaining ones are at the sides of the skull and are closed soon after birth.

The *Face* (Fig. 5) contains 14 bones. The 2 *nasal* (nose) bones are small and oblong, placed side by side at the upper part of the face, forming the bridge of the nose; 2 *superior maxillary*, form the upper jaw, the roof of the mouth, the floor and outer wall of the nose, and the floor of the orbit (eye socket); 2 *lachrymal*, resemble a finger nail in form, and form the front part of the inner wall of the orbit; 2 *malar*, or small square bones, which form the prominence of the cheek and part of the orbit; 2 *palate*, situated at the back of the nose and help to

form the wall of the nose, the roof of the mouth, and the floor of the orbit; 2 *inferior turbinated*, are small bones shaped like a scroll, one on each side of the outer wall of the nose; the *vomer*, thin, like a ploughshare, forms the septum (partition) of the nose; the *inferior maxillary*, the largest bone of the face, forms the lower jaw, and contains the lower teeth. This bone changes in size and shape during life. In old age it becomes reduced in size and the angle of the jaw becomes obtuse.

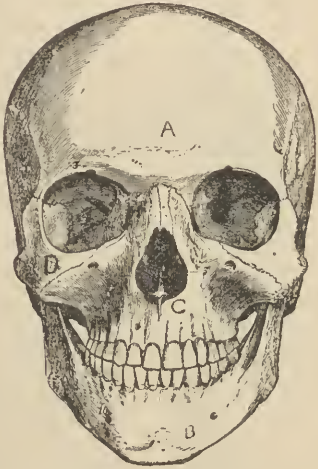

FIG. 5.—FRONT VIEW OF SKULL. A, Frontal; B, Inferior Maxillary; C, Superior Maxillary; D, Malar.

The *Orbits* (eye sockets) are two cavities at the upper part of the face, formed by the union of seven bones. They contain the eyes, their muscles, and a large amount of tissue which makes a cushion for the eyeballs to rest upon.

The *Nasal Fossæ* are two irregular cavities in the middle line of the face, formed by the union of 14 bones, and provide for the attachment of muscles and tissue to form the nose.

The *Hyoid* bone is situated at the base of the tongue, and acts as a support for it, and an attachment for its numerous muscles. It is shaped like a horseshoe, and does not articulate (joint) with other bones.

The *Spine* (Fig. 6) is a flexible column formed of a series of bones called *Vertebræ*. They are 33 in number, and are divided into (from above down) the *cervical*, 7; the *dorsal*, 12; the *lumbar*, 5; the *sacral*, 5; and the *coccygeal*, 4. In adults, the vertebræ forming the sacrum and the coccyx become firmly united, making two distinct bones.

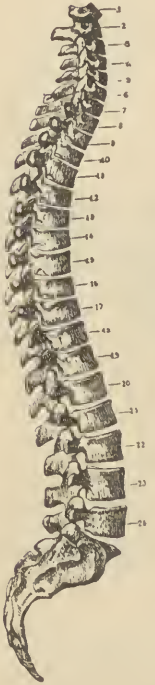

FIG. 6.—THE SPINAL COLUMN. 1–7, Cervical Vertebræ; 8–19, Dorsal; 20–24, Lumbar.

Each vertebra consists of a solid segment (the body) and a posterior segment (the arch). When the vertebræ are piled one upon the other, they form a strong column for the support of the cranium and trunk. The arches form a hollow cylinder, in which is contained the spinal cord. The vertebræ are separated by a strong, thick cartilage (gristle) which acts as a cushion, and serves to make the spine very flexible. These cushions also, subjected to the weight of the body during the day become compressed, and again expand when the body is in repose.

The *Atlas* is the first cervical vertebra, and supports the head. The *Axis* is the second vertebra, and forms the pivot on which the head rotates. It has a strong process (projection) which acts as a pivot.[1] The twelve ribs are attached to

[1] In hanging by the neck, this process is frequently broken, and presses on the spinal cord, causing instant death. This is what is termed a "broken neck."

either side of the dorsal vertebræ. The lumbar are the largest of the vertebræ. The *Sacrum*, in adults, is a large triangular bone, and is inserted like a wedge between the two pelvic bones.

The *Thorax*, or *Chest* (Fig. 7), which contains and protects the principal organ of respiration (lungs) and of circulation (heart and blood-vessels), is the largest of the three cavities of the body, and is formed by the *sternum* (breast bone), the twelve ribs on each side, and the bodies of the dorsal vertebræ behind.

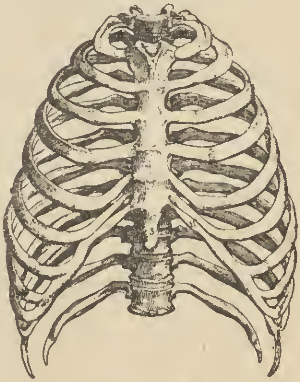
FIG. 7.—FRONT VIEW OF THORAX.

The *Sternum* (breast bone) is a flat, narrow bone, situated in the middle of the front of the chest, and consists of three portions. The ribs are connected to it by cartilages, known as *costal cartilages* (gristle).

The *Ribs* are elastic arches of bone, which form the chief part of the chest walls. They are twelve in number on each side, but this number may be increased or diminished by one. The first seven ribs are connected with the sternum by the costal cartilages. The remaining five are *false ribs*, the first three being connected in front to the costal cartilages, and the last two being free at their anterior extremities, and are termed *floating ribs*. The ribs increase in length from the first to the seventh, when they again diminish to the twelfth. The space between the ribs is termed the *intercostal space*.

The *Clavicle*, or *collar bone*, forms the front part of the shoulder. It is a long bone curved like the italic letter *f*. It lies immediately above the first rib, and articulates by its inner extremity with the sternum, and by its outer extremity with the scapula.

The *Scapula*, or *shoulder blade*, forms the back part of the shoulder. It is a large flat bone, triangular in shape, at the posterior part of the chest. A prominent plate of bone crosses the upper part of the scapula, known as the spine. This bone affords attachment for a large number of muscles of the chest and upper extremity.

CHAPTER II.

THE BONES, ARTICULATIONS (JOINTS), LIGAMENTS, AND CARTILAGES.

THE *Extremities*, or *limbs*, are the parts of the body which are connected with it at one end, and are free at the other. They are four in number: An upper pair, connected with the chest; and a lower pair, connected with the pelvis.

The *Upper Extremity* (Fig. 8) consists of the *Arm*, *Forearm*, and *Hand*.

The *Humerus*, or *arm bone*, is the longest bone of the upper extremity. It has a rounded head, which is joined to the shaft by a smaller portion called the neck. The head makes a joint which allows the arm to move in any direction.

The *Forearm* is the portion of the upper extremity situated between the elbow and the wrist, and has two bones.

The *Ulna*, or *elbow bone*, is a long bone, placed at the inner side of the forearm. It is the longer of the two bones. Its upper end is of great thickness and strength, and forms the larger part of the elbow; and it has a strong process (projection) fitting into a cavity in the humerus, called the *olecranon*. It becomes smaller as it descends, and at the wrist is quite small.

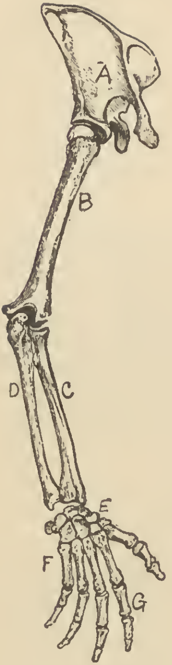

FIG. 8.—BONES OF THE UPPER EXTREMITY. A, scapula ; B, humerus ; C, radius ; D, ulna ; E, carpus ; F, metacarpus ; G, phalanges.

The *Radius*, or *wrist bone*, is smaller than the ulna, and, unlike it, is larger at the lower end, forming the chief part of the wrist.

The *Hand* is divided into three parts : The *Carpus*, or *wrist ;* the *Metacarpus*, or *palm* ; and the *Phalanges*, or *fingers*.

The bones of the *Carpus* are 8 in number, and are arranged in two rows. These are small cubical bones, fitting accurately with each other, and making joints with the bones of the forearm and the palm. Their shape allows the greatest amount of motion and suppleness.

The *Metacarpal*, or *palm* bones, are 5 in number. They belong to the class of long bones ; the bone of the thumb being the shorter, and of the index finger the longer.

The *Phalanges*, or *finger* bones, are 14 in number ; three for each finger and two for the thumb.

The *Lower Extremity* (Fig. 9) consists of the *Thigh*, *Leg*, and *Foot*, which correspond to the arm, forearm, and hand of the upper extremity. It is connected with the *haunch*, which corresponds with the shoulder.

The *Femur*, or *thigh* bone, is the largest and strongest bone in the body. It is almost a round shaft, with a head at its upper end connected with a shaft by

quite a long *neck*. It is this neck which usually breaks in old people who fall.

FIG. 9.—BONES OF THE LOWER EXTREMITY. A, pelvis; B, femur; C, tibia; D, fibula; E, tarsus; F, metatarsus; G, phalanges.

The *Tibia*, or *knee* bone, corresponds with the ulna of the forearm. It is situated at the front and inner side of the leg, and is the second largest bone in the body. Its head at its upper end is large and makes the larger part of the knee. In front it has a sharp ridge, called the *shin*.

The *Fibula* is the smaller bone of the leg, and is situated at the outer side of the leg. It is the most slender of all the long bones. Its lower part is quite small, and has a strong muscle attached to it, which causes it to frequently break (Pott's fracture).

Like the hand, the *Foot* is divided into three parts: The *Tarsus*, *Metatarsus*, and *Phalanges*.

The bones of the *Tarsus*, or ankle, are 7 in number, and present the same characteristics as the wrist bones. The *Os Calcis* is the largest of these bones, and forms the heel.

The *Metatarsal* bones are 5 in number, and belong to the long bones.

The *Phalanges*, or *toe* bones, both in number and arrangement, resemble those of the hand.

The *Patella*, or *knee cap*, is a flat, three-cornered bone, lying in front of the knee, and covering the joint. It has the muscles of the front part of the thigh and leg attached to it by tendons.

The *Pelvis* (Fig. 10) is a bony cavity which contains the abdominal organs. It resembles a basin, and is situated at the lower part of the spine, the sacrum making the back part of the pelvis. It is composed of 4 bones: the sacrum and coccyx previously described, and two *Ossa Innominata*, or nameless bones, so called from bearing no resemblance to any known object.

FIG. 10.—THE PELVIS.

A *Joint* (articulation) is the point at which two bones join and move upon each other. There are several forms of joints: *Gliding* joint, *Hinge* joint, *Ball-and-Socket* joint, *Condyloid* joint and *Pivot* joint.

A *gliding* joint is represented in the forward and backward motion of the lower jaw, and in the wrist and ankle joints.

A *hinge* joint is represented by the knee and elbow, which work only in one direction.

A *ball-and-socket* joint is round, permitting movement in any direction, such as the shoulder and hips.

A *condyloid* joint allows all varieties of angular movements, as in the palm and finger joints.

A *pivot* joint allows only rotation, such as the head on the spine (the axis).

Joints are held together by a strong, tough fibrous membrane, called *Ligaments*. These tough bands sometimes surround and "cage" in the joints, as in the hip and shoulder, and are called *capsular* ligaments. Hence, in dislocations, or when a bone is thrown "out of joint," these ligaments are ruptured, the end of the bone protruding through them. Some of the joints

FIG. 11.—SHOULDER JOINT, SHOWING THE LIGAMENTS (*Gray*).

are very complicated, such as the knee, and injuries to such joints are more serious than in the case of simpler joints.

The Synovial Membrane.—In addition to ligaments, every joint is supplied by a *serous membrane*, from which there exudes (gives out) a fluid (synovial fluid) that lubricates (oils) the joint. This membrane is subject to inflammation (synovitis) and other diseases,

and when its function is impaired or destroyed, the joint becomes stiff.[1]

When ligaments are stretched or lacerated (torn) by an accident, it is called a *sprain*. Sprains are frequently as serious and as long in recovering as dislocations and fractures.

Cartilage (gristle) is a bodily tissue usually of a pearly or bluish-white color. It enters largely into the composition of the skeleton, and the development of bone begins with cartilage. Osseous (bony) points in the cartilage continue to grow until the only remaining cartilage is at the joint, where a thick smooth layer remains at the points where the bones rub against each other. Cartilage enters into the formation of the ear, nose, eyelids, and windpipe.

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[1] An illustration is articular rheumatism (acute rheumatism), which frequently destroys the function of joints.

CHAPTER III.

MUSCLES AND TENDONS.

MUSCULAR tissue forms the greater part of the flesh of the body,[1] and it is by its means that the active movements of the body are produced.

Muscles (Fig. 12) consist of *fibres*, which are collected into packets or bundles named *fasciculi*. The muscular fibres have the power of contracting by the power of the will, or the result of other *stimuli* (irritation). A large class of muscles that are subject to the will, or volition, are known as *voluntary* muscles. There are also other muscles which are entirely withdrawn from the control of the will, such as those of the heart, intestinal canal, etc., and these are named *involuntary* muscles. These two classes of muscles differ in their character and appearance.

FIG. 12.—MUSCULAR FASCICULUS SHOWING FIBRES (*Gray*).

The bundles, or *fasciculi*, of muscles are connected by an investment or sheath of tissue which surrounds the entire muscle. Muscles are not attached at their

[1] "The muscular system in a well proportioned man is equal to about two fifths of the weight of the body."—*Sappey*.

extremities by the fibres, as a rule, but the fibres end in a strong fibrous band, cartilaginous in character, that forms the attachment to bone, called *Tendons.*

Muscular fibres are quite uniform in size, being about $\frac{1}{500}$ of an inch in diameter, and about one and one half inches in length. When these are bound together, a fasciculus appears to be continuous from tendon to tendon.

If viewed under a microscope (Fig. 12), the fibres are seen to be marked with light and dark bands, passing across them with great regularity. This cross-striped appearance is noticed only in voluntary muscles, and is called *striated* fibre.

Muscles when acted upon by the proper stimulus, or at the demand of the will, *contract*, or shrink, so as to bring their extremities nearer together. The result is that whatever the muscle is attached to must move. This power of muscle is called *contractility.*

Between the muscles, and in the substance of the muscles between the bundles of fibres, there is always some adipose tissue (fat).

Muscular contractility is lost within a few hours after death. Experiments have shown, however, that thirteen hours after death, by the injection of fresh blood through the vessels, contractility can be partially restored.

The power of a muscle to contract is limited, and after a time it becomes exhausted and will not respond to stimulation. There must be an interval of rest. The heart, which is an involuntary muscle in constant action, has an interval of rest between each contraction. This is also shown by the fatigue which follows standing in one position.

Flexion and Extension.—The *voluntary* muscles are divided into two great classes: (1) those which act in flexing (bending) a limb, and (2) those which act in extending (straightening). The first class are called *flexor* muscles, and the second class *extensor* muscles. These act in opposition to each other, and when they act equally, the limb is rigid. Hence, in standing in one position the flexor and extensor muscles act with equal force.

The number of voluntary muscles in the human body is 240. They are of various forms. Some are broad and thin, others are more or less elongated, others are round and of varying thicknesses. They are adapted to the situation and work they have to perform, and assist in forming the contour or shape of the body.

The *origin* of a muscle is the point of attachment at one end, and the *insertion* is the point of attachment at the other. They are also divided into layers known as *superficial* and *deep*.

The *involuntary* muscles are those either wholly or in part independent of the will, and that act automatically. They differ from the voluntary muscles in not being striated (striped), except the heart muscle. They are the muscles that make the contractile tissue of the vital organs, such as the intestines, bladder, stomach, etc.

The following is a list of the chief voluntary muscles of the body with their action.

THE HEAD.

Occipito frontalis, moves the scalp and eyebrows.
Orbicularis palpebræ, closes the eye.
Levator palpebræ, opens the eye.
Recti (4 in number) move the eyeball.

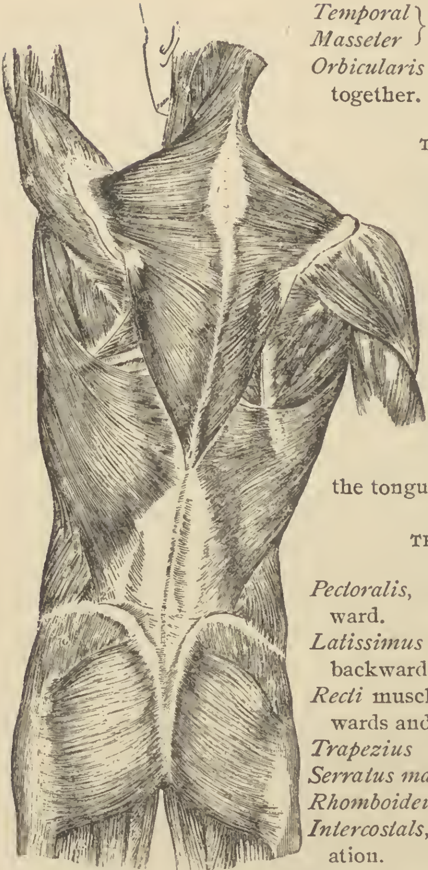

FIG. 13.—MUSCLES OF THE BACK, SHOULDER, AND HIP.

Temporal } raise the lower jaw.
Masseter }

Orbicularis oris, draws the lips together.

THE NECK.

Sterno-mastoid, moves the head forwards.

Scaleni, move the neck from side to side.

The hyoid muscles (3 in number) used in swallowing.

The glossi muscles (3 in number) move the tongue.

THE TRUNK.

Pectoralis, moves the arm forward.

Latissimus dorsi, moves the arm backward.

Recti muscles, draw head backwards and rotate it.

Trapezius }
Serratus magnus } move shoulder blade.
Rhomboideus }

Intercostals, move ribs in respiration.

Oblique muscles, move the trunk forward.

Erector spinæ, move the trunk backward.

Diaphragm, in respiration and coughing.

FIG. 14.—MUSCLES OF THE BACK OF THE FOREARM, AND TENDONS OF THE PHALANGES.

THE UPPER LIMB.

Deltoid, raises the arm.
Teres major, lowers the arm.

Subscapularis *Spinatus*	rotate the arm.
Biceps *Brachialis*	bend forearm.

Triceps, straightens forearm.

Pronator *Supinator*	rotate forearm.
Flexor carpi radialis *Flexor carpi ulnaris* *Extensor carpi radialis* *Extensor carpi ulnaris*	move the hand.

(More than thirty muscles take part in moving the fingers.)

THE LOWER LIMB.

Iliacus *Psoas magnus* *Pectineus* *Adductor*	move the thigh forwards.
Gluteus *Pyriformis*	move the thigh backward.

Quadratus, rotates the thigh.
Sartorius, crosses one thigh over the other.

Rectus *Vastus*	move the leg forward.
Biceps *Gracilis*	move the leg backward.
Tibialis *Gastrocnemius* *Soleus*	move the foot.

(Twenty muscles take part in moving the toes.)

Muscles are not endowed with ordinary sensation, but have what is called *muscular sense*. Thus, the sense of fatigue and resistance are examples. This sense gives the power of estimating weight, of standing erect with the eyes closed, etc.

If a muscle is allowed continued rest, it wastes, or becomes smaller, and, on the contrary, it grows under the influence of exercise. This is shown in the increased size of the right arm over the left. The importance of well modulated exercise, in keeping the muscular system in a healthy condition, is very great. The exercise should be of such a character as to equally distribute muscular action, therefore, exercise that will bring all parts of the body in action is to be preferred. The simplest form of exercise is walking, and nearly all parts of the body are brought into action by it. Horseback riding is still better. Bicycle riding does not bring into use the muscles of the upper limbs and trunk and lower limbs equally; the muscles of the lower limbs are used out of proportion. Rowing and swimming also bring into use nearly all of the muscles of the body. That form of exercise should be selected that will most equally distribute muscular action.

Exercise, particularly if violent, should not be taken immediately after eating. The blood is diverted from the stomach and digestion is retarded, and the food is forced into the intestines before stomach digestion is complete.

The *blood-vessels* of muscular tissue are very abundant, and every fibre is supplied by its capillary. When a muscular fibre is contracted, the blood is attracted to it to remove the element that has been consumed or wasted, and to supply new material. Thus, one of the

first effects of exercise is the increase in the number of respirations, and the number and power of the heart beats.

Tendons have no contractile power, and only serve the purpose of attaching the muscle to the bone. They are sometimes very long, as in the case of the tendons of the hand and foot.

FIG. 15.—MUSCLES OF THE SIDE AND THE BACK OF THE LEG.

The *Tendo Achilles* (Fig. 15),[1] the thickest and strongest tendon in the body, is formed by the union of the flat tendons from the large muscles at the back of the leg, and is inserted in the *os calcis*, or heel bone.

The *Diaphram*, or *midriff*, forms a muscular partition between the abdominal and chest cavities. It consists of muscular fibres which arch upward, to unite to a tendon in the centre. Its chief action is in the movements of respiration, for which it bears an equal part with the muscles of the chest walls. When the

[1] Called after the hero of the Grecian poet, the fable relating it was that at this point he received his death wound, no other part of his body being vulnerable.

chest muscles are hampered by tight lacing, or other means, respiration depends almost wholly upon the diaphragm. Its contraction, also, is the chief means of emptying the stomach by vomiting. Hiccough is a result of a convulsion of this muscle, which is also true of sneezing, coughing, laughing, and sobbing.

CHAPTER IV.

THE SKIN, NAILS, HAIR, AND TEETH.

THE *Skin* (Fig. 16) is the outer covering of the body and is one of its most complex and important structures.

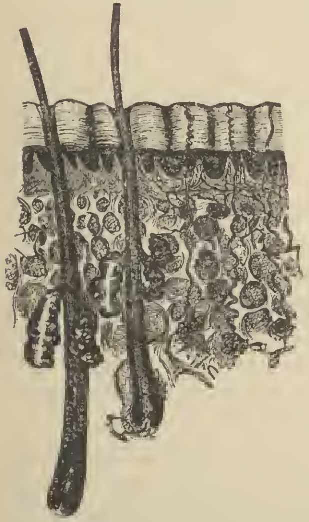

FIG. 16.—SECTIONAL VIEW OF THE SKIN (MAGNIFIED) SHOWING ROOTS OF THE HAIR, SWEAT AND SEBACEOUS GLANDS (*Gray*).

It forms a protective covering. It is quite thick over the parts subjected to friction and pressure. It is elastic over many movable parts, and is covered by hair in places, to afford additional protection.

The skin is a poor conductor of heat, and is therefore capable of resisting considerable variations in temperature, tending to maintain a uniform heat of the body.

The skin is divided into the *scarf-skin* and *true skin.* The *Epidermis*, *cuticle* or *scarf-skin*, varies in thickness in different parts of the body. It is thickest in the palms of the hand and the soles of the feet, where it is

much exposed to pressure, and is the thinnest on the face, eyelids, and external ear. It serves as a protection to the more delicate structure of the true skin. It is being constantly worn off, and falls away in the form of very fine scales.[1] It is also continually forming anew from the inner layer. In some diseases such as scarlet fever, the upper layer of the epidermis comes off in sheets, and this process is called *desquamation*. In case of a burn or a blister, the scarf-skin is separated from the true skin, and the interval is filled with a watery fluid. As it is neither supplied with blood-vessels nor nerves, it is neither sensitive, nor will it bleed on being cut.

The *Cutis vera*, *derma*, or *true skin*, is closely united to the scarf-skin, and to the tissue beneath. It is made up of bundles of fibrous tissue interlacing with each other in every direction. Around the hair follicles and sweat glands are also minute muscular fibres. It is the contraction of these fibres which causes "goose flesh." It is freely supplied with blood-vessels and nerves. The skin is from $\frac{1}{50}$ to $\frac{1}{4}$ of an inch in thickness. The surface of the skin has small projections called *papillæ* (Fig. 17), which perfect the skin as an organ of touch, and they are most developed where touch is exquisite. Thus on the palms of the hands and ends of the fingers they are in close array. The regular curved lines observed on the palms of the hands and the soles

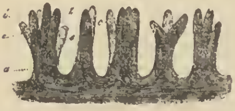

FIG. 17.—PAPILLÆ FROM THE PALM OF THE HAND.

[1] The skin is not a permanent sheath, but is, as it were, always wearing out and rubbing off, and new skin is always rising up from underneath. A snake leaves off his whole skin

of the feet are formed by double rows of papillæ. In the centre of each of these rows is a fine groove, in which are found the orifices of the sweat ducts.

The *Sebaceous glands* are found in all parts of the skin provided with hair, and as nearly every part of the body's surface presents either the long, short, or downy hairs, these glands are very generally distributed. They do not exist in the palms, or the soles of the feet. These glands on the face, and particularly about the nose and forehead, appear as small black points, which are sometimes called "worms."

Sebaceous matter is largely fatty, and the object of this secretion is to lubricate the surface of the skin and to give to the hairs that softness which they should have in a healthy condition. Thus the size of the glands depends upon the size of the hair it provides.

The *Sudoriparous*, or *sweat*, glands are, with few exceptions, in every portion of the skin. If the skin is examined with a magnifying glass, especially on the palms of the hands, the openings of the sweat ducts may be seen. A sweat gland consists of a simple tube coiled together like a snake beneath the skin. It is estimated that there are about three million sweat glands in the human body, and assuming that each gland when uncoiled measures $\frac{1}{10}$ of an inch, the entire length would be about three miles.

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at once, as we leave off a suit of clothes or a dress, and sometimes we may find his whole cast-off covering turned inside out, just as he crept out of it. In man, generally, we do not notice the dead particles of the skin as it wears off; but where the cuticle is pretty thick, as on the soles of the feet, we can see it peel off in little rolls whenever we wash the feet in hot water. After scarlet fever, too, sometimes the dead skin comes off in great flakes, and from the hands almost like the fingers of a glove.—*Berners*.

Complexion.—In the deeper parts of the skin, there is a coloring matter (*pigment*) consisting of minute colored particles. The complexion depends upon the amount of this pigment. Its presence, in a greater or less amount, occasions the difference of complexion that exists in different races, and between the dark and light complexions of the white race. Freckles are due to an irregular increase of this pigment.

The sun has a marked influence in increasing this pigment, and the difference is shown in the complexion of residents of tropical climes from those of northern countries.

The importance of the skin as an excretory (discharging) organ of the body is not generally appreciated. The continued shedding of the scarf-skin, the secretion and discharge of sweat and sebaceous matter, lead to a double source of defilement —from within and without. While these products are constantly accumulating upon the skin, their oily character attracts and holds floating dust and dirt. If the skin is not kept clean, its pores become clogged, and it becomes unable to perform its proper functions. To promote these functions the proper application of the bath is necessary.[1]

FIG. 18.—SECTION THROUGH THE END OF THE FINGER SHOWING THE NAIL.—(*Gould.*)

The Nails (Fig. 18) are situated upon the dorsal ends of the fingers and toes. They are divided into a *root*, a *body*, and a *free border*.

[1] See chapter on bathing, vol. ii.

The *root* which is thin and soft ends in a jagged edge, which is turned slightly upwards and is received in a fold of the skin. As the nail grows it is being constantly pushed forward, increasing in thickness as it advances.

The *body* of the nail is that portion uncovered, but adherent (fast) to the finger.

The *free border* is the portion at the end of the nail that is free from attachment, and the part of the nail that is cut off in trimming.

Disturbances of nutrition are shown by the nails. A severe illness will leave a contracted ridge. The nails also indicate diseases, an instance being the inward curve of the nail in pulmonary consumption.[1]

The finger nails should always be kept well-trimmed and smooth and the skin pushed back about their roots, to prevent "hang nails." The length of the nails should be moderate, and their edges smoothly rounded. Long nails are receptacles for dirt, and short nails do not protect the ends of the fingers, which become clubbed in time. If by any means a nail should be destroyed, a new nail will grow in its place.

The Hair.—Hair covers nearly every part of the body. The only parts in which hairs are not found, are the palms of the hands, soles of the feet, and the upper eyelids. Some of the hairs are long, others are short and stiff, and others are fine and downy. A hair consists of a *root*, the *shaft* or *stem*, and the *point*.

The *root* of the hair is embedded in the follicular

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[1] The average rate of growth of the nails is $\frac{1}{32}$ of an inch per week. They grow faster in summer than in winter, and faster in the right hand than the left. The growth is most rapid upon the middle finger and slowest upon the thumb.

openings of the skin. It swells out at its lower end into a bulb, or knob, and is received into a recess of the skin (*hair follicle*). The depth of the root depends on the size of the hair.

The *stem* is often more or less flattened,[1] and becomes gradually smaller towards the point. Its length and thickness vary greatly in different races as well as in different regions of the body. Light-colored hair is usually finer than black. The number of hairs on the head is estimated at 120,000. A healthy hair is elastic, and may be stretched from one-fifth to one-third its length. Hairs are usually set obliquely in the skin. Their strength is considerable, an ordinary hair bearing a weight of six ounces. Hair has the property of becoming strongly electric, especially when the weather is cold and dry.[2]

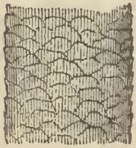

FIG. 19. — SURFACE OF A HAIR (MAGNIFIED).

The *structure* of the hair (Fig. 19) is a fibrous substance, covered by a thin layer of cells. The fibrous substance contains the pigment or coloring matter.[3] Hairs are not provided with blood-vessels or nerves.

The *scalp* throws off the scarf-skin, like other parts of the body, while the glands of the scalp are very active, pouring out their secretion, which, being of an oily nature, catches floating particles; therefore the

[1] Straight hair is cylindrical, and curly hair is flattened.

[2] Combing the hair in a dark room with a rubber comb will illustrate this.

[3] There are few well-authenticated instances of the sudden blanching of the hair, and the possibility of the hair becoming gray in a few hours cannot be doubted. In these cases the pigment is not destroyed, but the fibrous substance is filled with air, which changes the appearance of the hair by refraction.

hair and scalp require frequent cleaning. The best method is to brush it frequently with a soft brush. The scalp should be brushed, not merely the hair. Brushing stimulates the growth of the hair, and, under ordinary circumstances, is sufficient to keep the skin and the hair of the scalp in good condition, washing being only occasionally required. Where washing is necessary, plain Castile soap and water, or, where there is a tendency to dandruff, a solution of borax in water, may be used to advantage. The scalp should be thoroughly dried after washing, and no one should venture out of doors in cold weather while the hair remains at all moist.

The Teeth.—In the human subject two sets of teeth make their appearance during life. The first are the *temporary*, or *milk*, teeth (20 in number), and the second are the *permanent* (32 in number).

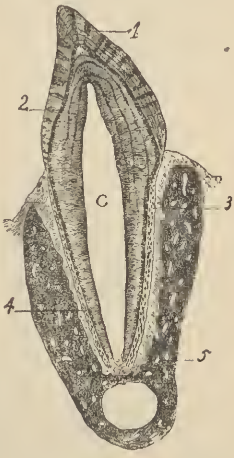

FIG. 20.—VERTICAL SECTION OF A TOOTH. C, Pulp Cavity; 1, Enamel; 2, Dentine; 3, Cement; 4, Periosteum; 5, Lower Jaw-bone.

A *Tooth* (Fig. 20) consists of three portions, viz., the *body*, or *crown*, which projects above the gums; the *root*, consisting of one or more *fangs*, and which is fixed in the socket below the gums; and the *neck*, which is the short part between the first two.

An *incisor* tooth, of which there are eight, is so named from being adapted to cutting or dividing food.

The crowns are chisel-shaped, and have a sharp, cutting edge, which is bevelled in the upper teeth, but in the lower ones is worn down. The *root* is a single long fang.

A *canine* tooth, of which there are four, is larger and stronger than an incisor. The crown is thick and conical, and ends in a single point. The root consists of a single fang, longer and thicker than that of the other teeth.

A *bicuspid* tooth, eight in number, is shorter and

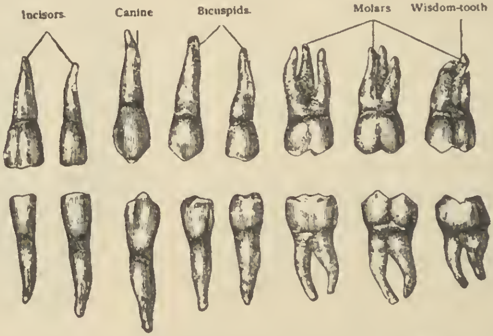

FIG. 21.—THE TEETH OF AN ADULT—(*Gould*).

smaller than a canine tooth. The crown has two points (*cusps*). The root has a single fang, which is broader than the incisors or canine.

The *molar* teeth, twelve in number, are arranged behind the bicuspids. They have a large crown with a wide top, or grinding surface. The roots have two or more fangs. The last molar is called the *wisdom tooth*, from its late appearance in the gum.

The *milk* teeth appear successively, in the following

order, the corresponding teeth appearing a little earlier in the lower jaw:

The 4 central incisors appear 6 to 8 months after birth.

The 4 lateral incisors appear 7 to 12 months after birth.

The 4 anterior molars appear 12 to 18 months after birth.

The 4 canines appear 16 to 24 months after birth.

The 4 posterior molars appear 24 to 36 months after birth.

The *permanent* teeth appear as follows:

The 2 central incisors of the lower jaw appear between the 6th and 8th years.

The first molars appear between the 6th and 7th years.

The 2 central incisors of the upper jaw appear between the 7th and 8th years.

The 4 lateral incisors appear between the 8th and 9th years.

The 4 first bicuspids appear between the 9th and 10th years.

The 4 canines appear between the 10th and 11th years.

The 4 second bicuspids and the second molars appear between the 12th and 13th years.

The third molars appear between the 17th and 21st years.

If a tooth is cut in two, it will be seen to have a cavity, which is called the *pulp* cavity (Fig. 20, C). It

contains a soft, highly vascular, sensitive substance, called the *dental pulp*.

The *dentine* is the hard part of the tooth which makes its greater part.

The *enamel* is the hard white covering which protects the crown. It is the hardest part of the tooth, but is gradually worn down by use.

CHAPTER V.

THE CIRCULATION OF THE BLOOD.

THE *circulation of the blood* is maintained by the *Heart* through the *Arteries* and *Veins*.

The blood passes from the left side of the heart into the arteries and is distributed to all parts of the body. It is collected by the veins and returned to the right

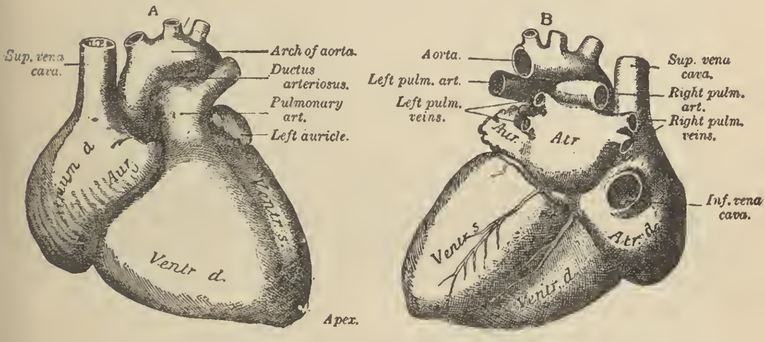

FIG. 22.—VIEW OF THE HEART. A, Front View ; B, Back View.—(*McAllister.*)

side of the heart, whence it is forced through the lungs into the left side of the heart, making a complete circuit in twenty-three seconds. The circulation from the left heart through the body to the right heart is called the *greater* (or systemic) *circulation*, and from

the right heart through the lungs to the left heart the *lesser* (or pulmonic) *circulation.*

The Heart.—The heart (Fig. 22) is a hollow, muscular organ, divided by a septum (partition) into a right and a left half. Its shape is that of a pear, with the small end (apex) downwards between the 5th and 6th ribs, and about three inches from the middle line of the chest. Its weight is 8 to 10 ounces in the female and 10 to 12 ounces in the male. The two sides of the heart have another division, named the *auricles* and *ventricles.* Of these the ventricles are the larger.

The division of the heart into a right and left side is equivalent to separate organs, and one is known as the left and the other the right heart. They have no direct communication. Their functions are also distinct, the left heart forcing arterial blood into the arteries and the right heart forcing venous blood into the lungs for purification. The heart has an oblique position in the chest, and lies more on the left side.

The *pericardium* is a serous sac in which the heart lies entirely free, and is attached at its base with the great blood-vessels. The pericardial walls are very smooth, and are bathed with a serous fluid, which reduces the friction from the constant motion of the heart to the minimum.

The *right auricle* receives the venous blood from the body through the large veins known as the venæ cavæ, and empties it into the right ventricle. The walls of this chamber are quite thin as compared with the ventricle, measuring about one line ($\frac{1}{10}$ of an inch).

The *left auricle* receives the blood which comes from the lungs by the pulmonary veins. It does not differ materially from the right, although it is a little smaller,

and its walls are thicker, measuring about a line and a half. It has four openings by which it receives the blood from the four pulmonary veins. These openings do not have valves. Like the right also it has a large opening by which the blood flows into the left ventricle.

The *ventricles* constitute the bulk of the heart. They have a capacity somewhat greater than the auricles, and are provided with thick, muscular walls. It is by this powerful muscle that the blood is forced through the body and the lungs.

The *left ventricle* occupies the left border of the heart. It is longer and narrower than the right. Its walls are much thicker than that of the right side, being seven lines, or a little more than half an inch in thickness. The shape of its cavity is oval. It has two openings that are controlled by valves. The opening receiving the blood from the auricle is controlled by the *bicuspid*, or *mitral*, valve. When the ventricle contracts, this valve closes, and prevents the blood from flowing back into the auricle. The other opening is into the large blood-vessel, the *aorta*. It is circular in form. The valves are three flaps that close when the ventricle dilates (opens), and prevents the blood from returning into the heart.[1] There are about two ounces of blood discharged with each contraction of the heart. All the cavities of the heart have a thin lining membrane, which is also continuous in the great blood-vessels, called the *endocardium*.

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[1] The valves of the heart are its parts that are most frequently affected in disease. They become inefficient, and put additional labor on the heart to supply the inefficiency, thus exhausting it.

The *right ventricle* occupies the chief part of the front of the heart. The wall of this cavity is thickest at the base, and becomes thinner towards the apex. Like the left ventricle, it has two openings—one into the auricle, and one into the pulmonary artery. The valve guarding the auricular opening is divided into three parts or flaps, and is called the *tricuspid* valve. The valve governing the opening into the pulmonary artery is much like the corresponding valve on the left side, and is called the *semilunar* valve.

The substance of the heart is of a deep red color, and is almost entirely composed of muscular fibre. It is an involuntary muscle and works independently of the will. No effort of will power can change its action. The fibres traverse the heart in all directions.

Movements of the Heart.—When the heart dilates, it is called *diastole*, and when it contracts, *systole*. A complete action of the heart is the filling and emptying of all its cavities. Between each complete action there is a short period of repose, when the heart is at rest. The impulse of the blood forced into the vessels, is carried throughout the body, and this is called the *pulse*, usually felt at the front part of the wrist, on the side of the thumb. When the heart contracts, it makes a sound which is known as the first sound. This is immediately followed by a second sound, and this is followed by a short interval of silence. It is by changes in the character of these sounds that disease is frequently recognized. The alternate contraction and expansion of the heart constitute the heart beats. The average number of beats in an adult man is about 72 in a minute. However, the heart's action is easily influenced, and exercise, digestion, heat, etc., increase it, while any-

thing that depresses the vital powers reduces it. Thus the difference between sitting and standing changes the heart beats ten in a minute.

Arteries.—The vessels which carry the purified blood to all parts of the body from the heart, are called *arteries*. The name is derived from the ancient belief that these vessels contained air. As a rule, arteries are nearly straight, taking the shortest course to the tissues they are to supply. They are cylindrical in form. They have three well-defined coats: An external coat of strong, fibrous tissue, a middle coat of yellow, elastic tissue containing a few muscular fibres, and an internal coat continuous with the lining membrane of the heart. The arteries are very elastic, strong, and have a slight power of contraction. With every beat of the heart, the arteries swell and are slightly elongated. This movement constitutes the pulse, and is easiest felt at the wrist, but is evident in every artery near the surface of the body.

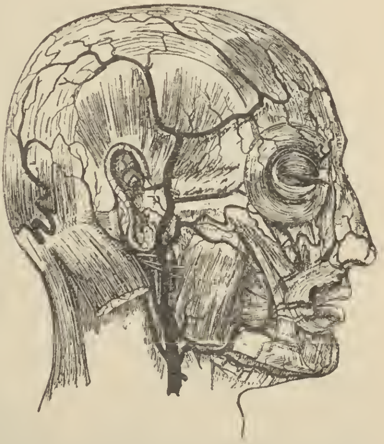

FIG. 23.—ARTERIES OF NECK AND FACE, SHOWING THE EXTERNAL CAROTID AND ITS BRANCHES.

The arteries usually occupy protected situations. They divide and subdivide as they proceed on their course, becoming smaller after each division, until they

reach the capillaries or smallest blood-vessels. Sometimes the divisions of arteries are united by a third branch, and this is called *anastomosis*. The advantage of this is evident, for if a vessel becomes incapable from any cause, the circulation will continue through this side connection.

FIG. 24.—ARTERIES OF THE FOREARM AND PALM OF THE HAND.

The Veins.—The veins like the arteries ramify throughout every portion of the body, and each artery has its corresponding vein. They are larger and more numerous than the arteries. The result of this increased capacity is that the blood does not flow as rapidly in the veins as in the arteries. The veins do not have the pulsating character of the arteries.

The veins are arranged in a superficial and a deep set, the former running immediately beneath the skin, and thence named *subcutaneous*. The veins have much thinner coats than arteries, and when they are cut across collapse, whereas a severed artery will maintain its shape. Veins also differ from arteries in having valves (Fig. 26), which prevent the blood from refluxing (going backward).

FIG. 25.—ARTERIAL SUPPLY OF THE INTESTINES.

The hæmorrhage from a cut vessel can be distinguished as *arterial* if it flows in spurts with some violence, and is bright crimson in color. If it flows sluggishly in a continuous stream, and is of a dark color, it is *venous* blood.

FIG. 26.—SHOWING THE VALVES OF A VEIN.

Between the arteries and the veins are minute blood-vessels called capillaries (Fig. 27). These vessels are too small to be seen by the naked eye and have a diameter of about $\frac{1}{3000}$ of an inch. They are the connecting links between the arteries and veins, and form a fine network in all of the tissues of the body, except hair, cartilage, and epidermis. These minute vessels have elastic walls, and with an increase in their size, a larger quantity of blood flows into them, and the part is reddened. An instance is blushing of the cheeks.

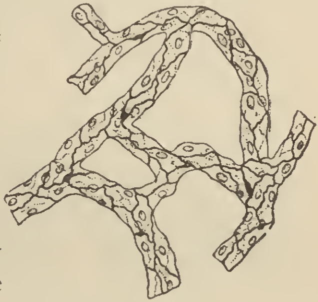

FIG. 27.—CAPILLARY BLOOD-VESSELS, SHOWING BLOOD DISCS.

The nutrition of the body and the carrying off of effete (worn out) products, is carried on by the capillaries. The walls of the capillaries are so thin, that the blood in them gives off and takes on matter through them, and this action is called *osmosis*.

CHAPTER VI.

THE BLOOD.

HUMAN *blood* is a fluid varying in color from a bright scarlet to a dark cherry-red, according as it is taken from an artery or a vein. If it is received in a bowl and allowed to stand, it *coagulates* (thickens) within a few minutes. In about half an hour the solid portion shrinks, leaving around the margin a straw-colored fluid. This coagulation is caused by the *fibrin* in the blood. The red color of the blood is caused by the red *blood discs*, or *corpuscles*.

FIG. 28.—HUMAN RED BLOOD CORPUSCLES.

The *blood*,[1] therefore, consists of two parts: the fluid portion, called the *plasma*, and the blood *discs*, *corpuscles*, or *globules* (Fig. 28).

The *blood corpuscles* are of two kinds—the red and the white. The red discs are by far the more numerous,

[1] The blood is described by Bernard as an internal medium which acts as a "go-between," or medium of exchange, for the outer world and the tissues.—*Landois*.

and are always those intended when the term "blood discs" is used. They are three to four hundred times as numerous as the white. Their size varies considerably in different animals, and it is possible to determine the source of blood by the size of the discs. In man they are about $\frac{1}{3500}$ of an inch in diameter. Under the microscope they appear like minute platters, being round, flat, with a raised border and a central depression. They collect in rows.

The difference in appearance between *arterial and venous* blood is caused by some change effected in the blood corpuscles. This change is caused by oxidation, or the exposure of the red corpuscles to the oxygen of the air in the lungs.[1] The red color is caused by the *hæmatin* (a form of iron) in the blood.

The *white corpuscles* are larger than the red, and have an irregular and granular surface. They resemble the cells found in lymph, chyle, and other bodily fluids, as well as in pus. They have a peculiar movement (amœboid), which gives them the power of passing through animal membranes. Thus they will pass through the shell membrane of an egg, if placed next to the suppurating surface. This property of the white corpuscle is the chief factor in inflammation.

The *plasma*, or *serum*, of the blood is the fluid portion. If obtained from the blood after a fasting period, it is of a transparent pale-yellow color. After a full meal it is opaque and milky, owing to suspended particles of fat. The *fibrin* can be separated from blood by

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[1] Blood free from oxygen is *dichroic*. By reflected light it is red and by transmitted light it is green.

"whipping" it with a bundle of twigs, to which it attaches in white, shiny strings. The plasma of the blood is very complicated, as may be supposed from the fact that it carries everything required for the nutrition of the body.[1]

A *thrombus* is the coagulation of the blood in a blood-vessel, forming a plug, which prevents the flow of blood through it. An *embolus*[2] is the formation of a plug which floats in the blood to a smaller vessel.

Anæmia is a deficiency of red blood discs. A marked increase in the proportion of white blood corpuscles is called *leucocytosis*. It is now possible, by appropriate apparatus, to count the number of blood corpuscles and to estimate the amount of coloring matter in the blood.

The *lymph* is the secretion of a system of glands and vessels which takes up from the worn-out tissues that which can still be used for the purpose of nutrition, and returns it into the veins close to the heart, there to be mixed with the mass of the blood. As its name implies, it is a watery fluid. It contains some corpuscles similar in appearance to the white corpuscles of the blood. The system of lymph vessels and glands is known as the *lymphatic system*. It is an aid to the circulation of the blood in the removal of waste. If the

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[1] A complete clinical record of a case should give the number of red and white blood corpuscles to the cubic millimetre, and the percentage of hæmoglobin. The number of red discs in health is estimated at 5,000,000 per c. mm., the hæmoglobin in health being estimated at 100 per cent.

[2] The cause of paralysis following rheumatism in which the heart has been affected is explained by the collection of fibrin upon the deficient heart valves, pieces of which break off and float into the smaller arteries of the brain and plug them.

blood-vessels are considered as irrigation canals, the lymphatics may properly be considered as drainage canals.

Chyle is the fluid secreted by the small intestine from digested food. It is mixed with the lymph and passes through the lymphatic vessels to be discharged into the blood. Besides the white corpuscles, it contains fatty granules, oil globules, and some blood discs. It is a milk-white fluid and coagulates on standing.

Lymphatic glands are collections of lymph follicles scattered in clusters throughout the course of the lymphatic vessels. These glands are frequently the seat of disease, particularly from any cause which poisons the blood.

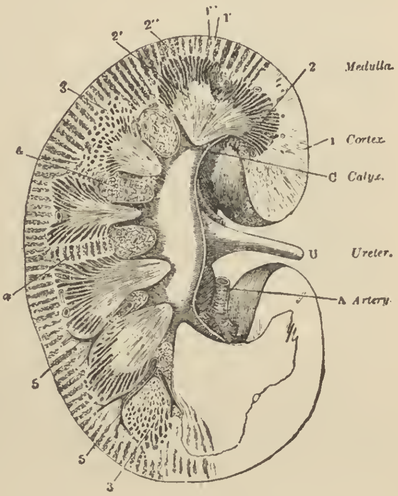

FIG. 29.—LONGITUDINAL SECTION OF A KIDNEY.

We have now considered the means by which the body is supplied with nutritive material, through the blood, the lymph, and the chyle. When this material serves its vital purpose and is worn out it is changed to other products, which are again taken up in the fluid of the body, and pass out of the body as waste material. This change of

material is called *metabolism*, and the taking up and throwing out is called *excretion*.

There are four channels for *excretion*: the *kidneys*, *intestines*, *lungs*, and *skin*.

The *kidneys* are two small organs shaped like a bean, one lying on each side of the lumbar vertebræ. A kidney weighs from four to six ounces, and the left is usually heavier than the right. The kidneys are covered with a thin, smooth membrane, which can be easily stripped off if the kidneys are healthy.

If a kidney (Fig. 29) is divided lengthwise, two distinct portions are seen: the outer, or *cortical*, substance; and the inner, or *medullary*, substance. A complicated network of vessels, through which certain effete matters are removed from the blood as urine, makes up the circulation of the kidney. If from any cause the function of the kidney is suspended, these elements remaining in the blood act as a poison, and give rise to various dangerous conditions. When the urine in the kidney is collected, it discharges through a duct connecting the kidneys with the bladder, called the *ureters*.

The *urine* is the chief excretion of the body. Therefore any disease that retards or affects this excretion is of great importance. As it comes from the kidneys by the ureters it discharges into the *bladder*, from which it is periodically discharged through the *urethra*. The capacity of the bladder is about three pints.

Examination of the Urine.—In the absence of the physician, the nurse is sometimes required to examine the urine. The points for ordinary bedside observation of the urine are the total quantity discharged during the twenty-four hours; its color; its odor; its clear-

ness; its specific gravity; whether it contains albumen or sugar.

(This will be explained in detail in the chapter on observation of symptoms.)

The *perspiration* is the fluid excreted by the skin (Fig. 30). The importance of the action of the skin is shown in the fact that if the body is covered with an impermeable coating, so that the skin cannot act, death occurs in a short time. Under ordinary conditions the sweat on the surface is not noticeable, as it evaporates as soon as it reaches the surface and passes off as vapor. When the sweat glands act too rapidly for evaporation, then it is noticeable, but the skin acts continuously, and it has been shown that the daily exhalation from the skin exceeds two pounds.

FIG. 30.—MAGNIFIED SECTION OF THE SKIN, SHOWING SWEAT GLANDS.

The *fæces* is the matter excreted by the intestines. Its color is due to bile pigment. The daily average quantity of fæces excreted by a healthy person is five ounces. It varies much in composition, and there is scarcely any disease that does not affect the intestinal excretion.

(The excretion from the lungs will be considered under the subject of Respiration.)

CHAPTER VII.

RESPIRATION; THE LUNGS AND AIR PASSAGES.

Respiration is the means by which the tissues and organs of the body receive oxygen, through the blood; and by which carbon dioxide and other effete matter is removed from the blood, in the form of gas.

When the blood leaves the right side of the heart, it is dark and impure, or *venous* blood. It enters the lungs, passes into the pulmonary capillaries surrounding the air cells, gives off its *carbon dioxide*, takes on *oxygen* from the air, and enters the left side of the heart *arterial*, bright and pure, and no longer injurious.

The *Lungs* (Fig. 31) are the special organs of respiration. They occupy by far the largest part of the chest cavity. Each lung is attached at its inner surface by a part called the *root*. All other parts of the lung are free, and its surface is closely covered by a serous membrane named the *pleura*.

The *substance* of the lungs is soft, elastic, and sponge-like. It is buoyant in water and floats. When rubbed between the fingers it gives a crackling sound, or *crepitus*, this being due to air in the air cells. The lung tissue is very elastic. When the chest cavity is opened the lungs collapse to about one-third of their bulk.

The *weight* of the lungs varies much according to

the quantity of blood they may happen to contain. The weight of both lungs ranges from thirty-six to forty-two ounces.

The *shape* of the lungs is conical, with the base downwards and point (apex) upwards. The base rests upon the diaphragm. The apex is blunt, and reaches into the root of the neck, above the first rib.

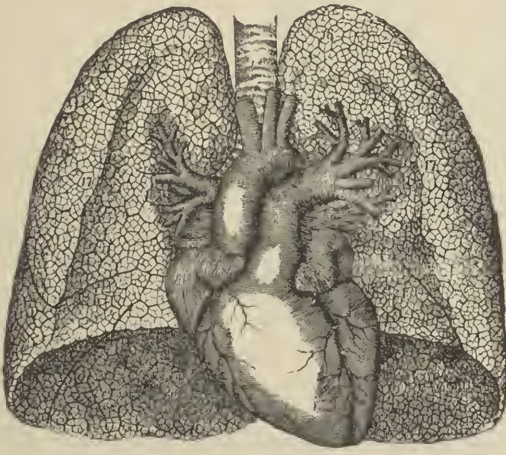

FIG. 31.—THE FRONT OF THE LUNGS, WITH THE HEART AND GREAT VESSELS IN POSITION.

The *lobes* of the left lung are two, divided by a long and deep fissure. The upper lobe is the smaller. In the right lung there are two fissures, making three lobes. The left lung has a deep notch in its border, into which the apex of the heart is received. Besides these differences the right lung is shorter than the left, as the liver pushes up the diaphragm on the right side.

The left lung is the narrower, owing to the space occupied by the heart.

The *roots* of the lungs are composed of the *bronchi*, or large air tubes, and the large blood-vessels.

The *air-cells* (Fig. 32) are oblong vesicles, collectively grouped at the extremity of each minute air tube. The walls of the air-cells contain abundant, small elastic fibres, which give to them great elasticity, and assist in expelling the air from them. Intermingled with these fibres are an immense number of capillaries, so that the air-cells may be said to be lined with blood-vessels, and their walls are so thin that the blood is substantially exposed to the air in the cells. This beautiful arrangement explains the rapidity with which the impure blood can give up its carbon and take on its oxygen.

FIG. 32.—END OF A BRONCHIAL TUBE AND AIR-CELLS (*Sappey*).

The *Trachea* (Fig. 33), or the windpipe, the common air passage for both lungs, is an open tube which commences above the larynx at the base of the tongue, and divides below into two smaller tubes, the *bronchi*, one for each lung. It is placed in the middle line of the body, and starts opposite the sixth cervical vertebra to a place opposite the fifth dorsal vertebra. It measures about 4½ inches in length, and about ¾ of an inch in diameter.

The *structure* of the *trachea* is a series of tough, cartilaginous rings, round, firm, and resistant. There are about twenty of these rings united together by fibrous and muscular tissue. It is lined by *mucous* membrane, which has on its surface a ciliated or fluted appearance. This has a wave-like motion, and assists in working the mucus and secretion upwards toward the mouth. It is nature's device to clear the lungs.

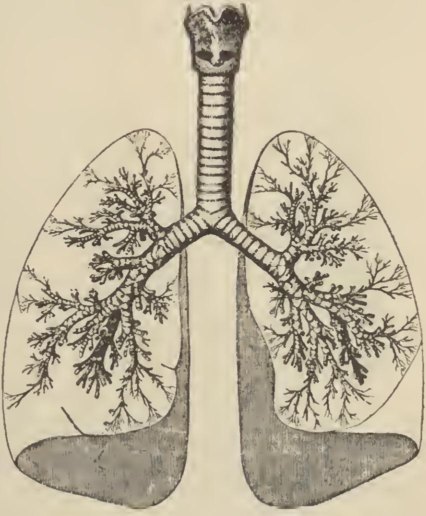

FIG. 33.—TRACHEA AND BRONCHIAL TUBES.

The *bronchi*, or the divided trachea, resemble the trachea in appearance and structure. The bronchi divide and subdivide until the smallest bronchial tubes end in the air-cells. The trachea and bronchial tubes resemble the trunk and branches of a tree (Fig. 33).

The *Larynx* is a box-like construction of cartilage at the upper extremity of the trachea, in which are located the vocal (voice) chords. The air passing over these stretched chords produces a vibration which makes the sound known as the voice. Covering the larynx is a cover which acts like the lid of a box on a hinge,

called the *epiglottis*. This closes during the act of swallowing, and prevents the food from getting into the trachea and lungs (Fig. 43). In case any substance should accidentally get into the trachea, there is a distressing sensation of choking, and it produces a severe fit of coughing to expel it. In feeding with the nasal and stomach tube, one of the chief dangers is the chance of passing the tube into the larynx or of injecting the fluid into the lungs, which results in suffocation or a serious inflammation.

The *mucous membrane* is continuous from the trachea throughout the bronchial tubes and larynx. It is this membrane that secretes the mucous and purulent matter that is coughed up in disease of the air passages; and when this membrane becomes inflamed it produces the disease known as *bronchitis*.

The *cilia* previously mentioned are also throughout the bronchial tubes. These hair-like processes have been likened to a field of grain moved by the breeze.

The *pleuræ* are serous membranes which cover the lungs and in which they move freely. It has two layers, one of which is attached to the chest walls (parietal), and the other to the lungs (visceral). These surfaces rubbing upon each other are very smooth, and are kept moistened by a secretion (serum) which reduces the friction of respiration. Inflammation affects the pleuræ, making their surfaces rough, which is the cause of great pain and impeded respiration. Sometimes after inflammation the surfaces unite, and this prevents the lung from contracting fully. In inflammation also, a fluid is secreted in large quantities, filling up the pleural sac and chest cavity, and making

respiration difficult. This is called *pleural effusion*, and is relieved by tapping.

The *movements of respiration* are of two kinds: the drawing of air into the lungs, called *inspiration*; and the forcing it out, called *expiration*.

Inspiration is caused by the lowering of the diaphragm and the elevation of the ribs. In other words, the chest cavity is enlarged in every direction (Fig. 34). In the taking of a long breath it will be noticed that the abdomen swells out, the chest walls broaden, and the shoulders are raised. The muscles that take part in respiration, besides the diaphragm, are chest muscles, assisted by the muscles of the neck and shoulder. In inspiration, the air rushes through the nose, trachea, and bronchi to reach the air-cells, which are enlarged to their full capacity. There is an interval of rest, which allows the blood in the walls of the air-cells to exchange its impurities for oxygen.

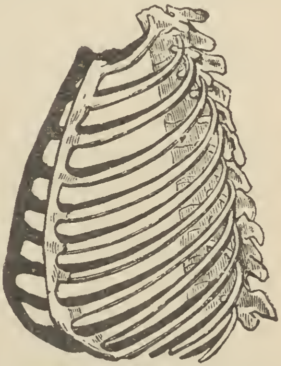

FIG. 34.—ELEVATION OF THE RIBS IN INSPIRATION. THE DARK LINES REPRESENT THE RIBS WHEN ELEVATED.—(*Flint*).

Expiration is caused by a passive return of the muscles to their ordinary state, and by the contraction of the elastic tissue in the walls of the air-cells, thus forcing the air out of the lungs. Expiration is slightly longer than inspiration. There is not sufficient air taken into the lungs to fill them, as it is estimated that

with each inspiration but twenty cubic inches of air is taken up, while the capacity of the lungs is two hundred cubic inches. After every sixth to eighth respiratory act, there is a longer respiration, or a deeper breath drawn, for the purpose of more completely filling the lungs. But in the deeper part of the lungs and in the smaller tubes and air-cells there is a current of air partially independent of the respiratory act, and this keeps the fresh air moving towards the cells. The air expired is also less than the air inspired, about $\frac{1}{50}$ being lost by the change of gases.

The *number* of respirations per minute in an adult in a state of rest is eighteen. Like the heart's action, this is increased by the least exertion, and also in diseases which reduce the lung capacity. When the respiratory act is chiefly effected by the diaphragm, it is called *abdominal* respiration, and by the chest muscles, *costal* respiration. Hence, if from any cause the chest walls are bound down,[1] the respiration is abdominal; and in painful affections of the abdomen, or when it is tightly bandaged, the respiration is costal.

The *sounds* produced by breathing in a state of health are not evident unless the ear is placed against the walls of the thorax. There is an instrument used for hearing the sounds of breathing, as well as of the heart, called a *stethoscope*.[2] There are two principal sounds produced by breathing. One is the *bronchial* sound, from the passage of air through the bronchial tubes, and the other is the *vesicular* murmur which resembles

[1] When a rib is broken the chest is strapped to keep the ribs quiet.

[2] There are several varieties of stethoscopes—some with a single tube and some with a double tube with an ear-piece for each ear. The latter variety is preferable.

the sighing of a light breeze through the trees. This is produced by the air moving in the air-cells. *Snoring* is produced when the air passes through the mouth and nose at the same time, and is the result of a vibration or flapping of the soft palate. The kind of disease in the lungs and pleuræ can often be determined by the changes in the character of the sounds produced.

Pure air is substantially composed of eighty parts of nitrogen to twenty parts of oxygen. It also contains some moisture. Expired air contains only sixteen parts of oxygen, four parts being lost in respiration. This amounts to a consumption of three hundred cubic feet of oxygen daily.[1]

We breathe without thinking. Respiration goes on whether we are asleep or awake, hence it is an involuntary act. But, on the other hand, we can "hold our breath," or we can breathe rapidly or slowly, which is an effort of the will. Therefore the respiratory act is a mixed one (voluntary and involuntary). The influence that operates on the nervous system to cause breathing is called the *respiratory sense.* If this part of the nervous system is paralyzed, breathing stops. Breathing is a reflex act,[2] caused by the irritation of carbon dioxide in the blood.

The "sense of *suffocation*" is caused by a grave interference with respiration, either by a poor quality of air or by a stoppage of the air passages.

Respiration by the skin, although very important in many of the lower animals, is very slight in man; still, it is appreciable, and is estimated to be $\frac{1}{40}$ of the

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[1] Air requirements will be further treated in the chapter on Atmosphere.

[2] See reflex action in chapters on the Nervous System.

respiratory function. We may then truly say "the skin breathes."

Asphyxia is the entire cutting off of the supply of oxygen to the lungs. Thus death by drowning, hanging, choking, etc., is caused by asphyxia.

CHAPTER VIII.

ALIMENTATION AND DIGESTION.

Alimentation is the act and method of supplying, and the capacity of receiving and assimilating,[1] the nutriment (food) of the body.

Digestion is the process by which the food is chemically changed, so that it can be assimilated, and used as a nutriment for the body.

Hunger is that peculiar want felt by the system, or craving, which leads to the taking of food, and *appetite* is the first manifestation of hunger.

The sensation of *appetite* is by no means disagreeable, and may be excited by the sight, smell, or by some recollection of food that has "tickled the palate and made the heart glad," even when there is no absolute want of food by the body. Appetite is very much influenced by habit, and the regular hour for meals usually produces it. If the appetite is not appeased it soon grows into hunger. When a sufficient quantity of food is taken into the stomach, appetite and hunger disappear, giving place to a feeling of satisfaction.

The appetite is modified by temperature, exercise, occupation, and habit. In cold climates, or during the

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[1] Assimilation is the process of transforming food into such a nutrient condition that it is taken up by the circulation, to form a part of the body.—*Gould.*

winter season, the desire for food is increased and more food is taken, particularly animal food and fats. Also, all forms of exercise have a marked influence, as well as mental occupation when not carried to excess. In nearly all forms of disease the appetite is reduced or disappears altogether. The use of opium and tobacco allays the appetite, and the abuse of alcohol takes away all desire for food.

ALIMENTATION.

If the appetite is not satisfied, hunger becomes an actual pain. There is an intense pain in the head, a feeling of distress, and the mind cannot be diverted from the all-absorbing desire for food. The distress continues until a furious delirium ensues, which soon ends in death.[1]

Thirst is the sensation that leads to the drinking of water or liquids. It is influenced by habit, some persons only drinking at meal-time, while others require water frequently. The condition of the atmosphere, exercise, and sweating influence it. After a great loss of blood the thirst is great. In cholera and diseases which cause copious bodily discharges the thirst is much increased. The demand of the system for drink is more imperative than for food, and is second only to the demand for oxygen. A man deprived of water and allowed only solid food will survive but a few days.

[1] There are many instances on record where starvation has led to murder and cannibalism (eating the human body). In the extremity of starvation, there is no restraint exercised by the will.

After deprivation of water for some time the thirst becomes distressing. The throat becomes dry and hot, and there is a sense of choking. The blood becomes thick and is lessened in quantity. Death takes place in a few days, preceded by delirium. The length of time life can be sustained without food or drink is uncertain.[1]

Aliment, or *food*, in its broadest sense, is any article containing substances which enable it to be used for the nourishment of the body. Aliment includes everything that nourishes the body—air, food, and drink.

Food usually has nutritious matter associated with matter that is not nutritious. It is the business of digestion to separate these and put the nutritious matter in a form to be appropriated by the body. Food also contains matter which, although not of a nutritious nature, improves the agreeable qualities of food and stimulates the appetite.

COMPOSITION OF FOOD.

Food belongs to the inorganic, vegetable, and animal kingdoms, and these form its great divisions. It is divided into,

(1) Nitrogenized substances (albumen, fibrin, casein, etc.), belonging to animal food, and gluten and legumine belonging to vegetables.

(2) Non-nitrogenized substances (sugars, starch, and fats).

(3) Inorganic substances.

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[1] The frigate *Medusa*, wrecked in 1816, had 150 persons on board who were exposed on a raft on the open sea for thirteen days. When they were rescued, only fifteen were alive.

Nitrogenous substances are contained in red meat (muscles), eggs, milk, the vegetable juices, grain, etc. A distinctive character of these substances is, that they contain nitrogen. They are all either liquids or semi-solid. Albumen, or the white of an egg, is the best illustration and they are sometimes called *albuminoids.* They are also known as flesh formers. These substances undergo a peculiar form of decomposition, called *putrefaction.*

Non-nitrogenous substances are sugars, starch, and fat. They are all composed of carbon, hydrogen, and oxygen. In sugars and starch the hydrogen and oxygen are in the proportion to form water, hence they are called carbo-hydrates.

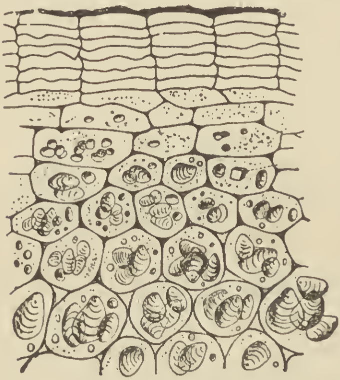

FIG. 35.—SECTION OF A POTATO, SHOWING STARCH GRANULES.

Sugars are of many varieties, and are derived from animal and vegetable sources. The common varieties of animal sugar are sugar of milk, and honey. The vegetable sugars are cane sugar (all varieties except that from fruit), grape-sugar (obtained from fruit). They have a sweet taste and are soluble in water. Starch is turned into sugar by digestion, and this form of sugar is called *glucose,* and is the only form in which sugar exists in the body.

Starch resembles sugar in its composition and is easily converted into sugar. It is found in vegetables,

grains, potatoes, etc. (Fig. 35). It is most abundant in rice. When starch is eaten it is almost immediately changed into sugar by the saliva. Although the carbohydrates are necessary parts of food, they will not sustain life alone.

Fats are important articles of food, and are derived from both animal and vegetable substances. Fat is found in all parts of the body except the bones, teeth, and cartilage. In animal food it is usually taken in the form of fatty meat (adipose tissue), and also in milk (butter). In vegetables, fat is abundant in seeds, nuts, grains, and fruits, particularly the olive. In this form it is called *oil*. When the fats are taken into the body they become alike and lose their identity. They are extremely important in food, but are not capable of sustaining life alone. It is supposed that the fats are concerned in the production of animal heat.

As the body is composed in part of *inorganic* (mineral) substances, so they must necessarily form a part of food.

Chloride of Sodium (common salt) is the one most widely found in the body, and it exists in all varieties of food. It is usually insufficient in food for the wants of the body, and is therefore added in necessary quantities. It also serves as a condiment, or appetizer.

Calcium Phosphate (phosphate of lime) is almost as common as salt. It makes up a large part of the bones, and it has been found that when the body has been deprived of this mineral the bones are seriously affected. In children, particularly, where the bones and teeth are in an active state of growth, its need is the greater.

Iron, which forms a large part of the coloring matter

of the blood, is also a constituent of food. It is unnecessary to enumerate all the other constituents of food. All the inorganic matter that is in the body is also in food.

Water is one of the most important elements of the body, and makes up a large part of all the food taken, besides that taken in a pure state. Take roasted meat, for instance, and 54 of 100 parts is water, the remainder being nitrogenous matter, fats, and inorganic matter. Water usually contains some minerals or salts in solution, and a certain quantity of air. Water that contains no air (boiled water) has a flat, or insipid, taste.

Alcohol has become such a common beverage, that it may with propriety be considered under the subject of diet, or food. It forms a part of all distilled liquors made from fermented juices of grain and fruit; of beers and wines. Pure alcohol is a clear colorless liquid that has a burning taste and evaporates rapidly. It is lighter than water and cannot be frozen. For this reason spirit thermometers are used for taking very low temperatures. It burns with a pale bluish flame, without smoke, and gives out an intense heat. It is used in the so-called spirit lamps.

Alcohol is absorbed and taken into the blood. It has been a long disputed question whether alcohol is changed in the body and assimilated, or whether it is discharged from the body unchanged. We can smell the breath of a person who has been drinking, and it would therefore seem that it is eliminated (thrown out) by the lungs in an unchanged state. It has also been shown to exist in the blood and in all the tissues and organs. But it has also been shown that when alcohol is taken in quantities not sufficient to produce

intoxication, it is largely consumed in the body and but a small quantity is thrown off.

If alcohol is taken in a moderate quantity it produces an exalted feeling which gradually passes off. It has, however, different effects, and it sometimes dulls the intellect and produces depression. If it is taken in large doses, or frequently repeated, the well known symptoms of intoxication are produced, and if the quantity be excessive, delirium, coma, or even death ensues. There is no doubt that in large doses alcohol is an active poison. In weak and exhausted conditions alcohol seems to supply an actual want, if given in small doses. When it is given in doses sufficient to create an exalted feeling, this is always followed by a corresponding feeling of depression.

Alcohol lessens the activity of nutrition. The body does not throw off as much waste matter when it is taken; therefore, if its use is long continued, it weakens the digestive function and does actual harm. In other words the use of alcohol is wholly unnecessary where a sufficient amount of food is taken. The body *temperature is lowered* by alcohol even in moderate doses; hence the body in alcoholic subjects cannot withstand the effects of cold as well as in others. When alcohol is first taken, it imparts a feeling of warmth, by dilating the blood-vessels, but the heat of the body is thus more rapidly radiated.[1]

Notwithstanding the evils that accompany the abuse of alcohol, as a remedial agent it has great value, and

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[1] Dr. Hayes, the Arctic explorer, says: "While fresh animal food, and especially fat, is absolutely essential to the inhabitants and travellers in Arctic countries, alcohol is, in almost any shape, not only completely useless, but positively injurious."

there are occasions when it cannot be substituted by any other equally efficient remedy. In every case, however, it should be prescribed and administered with the same accuracy as other powerful remedies. A nurse should never guess at quantities, merely because it is spirits or wine and more or less seems a matter of little consequence.

Alcoholic drinks are prepared by fermentation of starchy substances or sugar. Beer is made by the growth of the yeast plant in barley; wine, by the same growth in the juice of the grape. This process changes the sugar or starch into alcohol. Distilled liquors, such as brandy and whiskey, are made by distilling (vaporizing) the fermented products.

The following table gives the proportion of alcohol in the several forms of beverages:

	Whiskey	contains	50	per cent.	of alcohol.
	Brandy	"	50	"	"
	Rum	"	65	"	"
	Gin	"	50	"	"
(Strongest)	Port wine	"	25	"	"
(Weakest)	Port wine	"	17	"	"
(Strong)	Sherry	"	25	"	"
	Madeira	"	18	"	"
(Strong)	Claret	"	17	"	"
	Claret (vin ordinaire)	contains	8	"	"
	Champagne	"	5 to 13	per cent.	of alcohol.
	Sauterne	"	14	"	"
	Cider	"	5 to 10	"	"
	Ale	"	7	"	"
	Beer	"	4	"	"

CHAPTER IX.

FOOD AND DRINK (DIET).

Accessory Food.—There is a class of food that is not indispensable to life, yet that has been so generally used throughout all time that we must accept it as an element of diet. This class of food is composed of alcohol in the various alcoholic beverages, coffee, chocolate, cocoa, spices, etc. Some are used as stimulants, and others to render food more palatable.

A *mixed diet* is necessary to sustain life and maintain health for any length of time. The anatomy of the organs of digestion, experiment,[1] experience,[2] and the amount of carbon and nitrogen daily excreted indicates this. Observation has also shown that an excess in the use of any one of the classes of food above the demands of the body produces a constitutional weakness called *diathesis*. Thus, an excess of albuminous food pro-

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[1] Dr. Stark of London, in 1769, subsisted for forty-four days upon bread and water, for twenty-nine days on bread, water, and sugar, and for twenty-four days upon bread, water, and olive oil, until his health became impaired and he died in consequence.

[2] Seamen who are long confined to a diet of salt pork and bread, often suffer from a serious disease called *scurvy*. Sometimes in insane hospitals patients contract the same disease, from not varying their diet on account of their delusions.

duces the *gouty* diathesis; of oily food, the *bilious* diathesis, etc.

Vegetarianism, or the exclusive use of a vegetable diet, was at one time a popular fad, now almost wholly disappeared. It was chiefly based upon a sentiment. A mixed diet more easily furnishes the necessary substances called for by the body, and the human digestive organs indicate that they were intended for both animal and vegetable foods. It must be admitted, however, that all the elements of the body are contained in vegetable food.

A *modification* of the diet is rendered necessary by the climate, occupation, and sickness. It is well known that the inhabitants of the frigid zone eat large amounts of carbonaceous food, in the shape of the fat of seals and whales, while those in hot climates depend largely upon starchy food and fruit. A person in the winter seems to demand more fat and animal food than in the summer.

The *cooking* of food increases its palatable qualities, and makes its digestion easier.[1] This includes boiling, roasting, frying, broiling, baking, etc. In the starchy food, boiling, or the addition of water when the heat is applied, breaks the starch granule and thus far aids digestion. But in the cooking of meats without the addition of water, as roasting, broiling, baking, and frying, if it is too "well done," or charred, the albuminous substances are so far coagulated as to destroy their nutritive qualities. The principle of this form of cookery is to suddenly apply a very high heat,

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[1] The preparation of food for the sick is treated in the appendix to vol. ii.

so as to harden the surface and hold the juices in the interior. Baking and frying require a higher and longer continued heat, and are therefore less desirable. Young meats, as poultry and fish, require a higher temperature and more thorough cooking. The mineral matters or salts are better dissolved and prepared for digestion by cooking.

The *proper daily amount of food* required to keep the body in a perfect state of health, depends so much upon circumstances that the best guide is generally afforded by the appetite. When the appetite is satisfied, eating should stop, although the savory quality of the food may still make eating a pleasure. Distension of the stomach by over-eating is sure to result in dyspepsia.

Dr. Letheby gives the requirements of the average man in idleness as 2½ ozs. of nitrogenous, and 19½ ozs. of carbonaceous food; at ordinary labor, as 4½ ozs. of nitrogenous and 29 ozs. of carbonaceous food; and at active labor as 6 ozs. of nitrogenous, and 35 ozs. of carbonaceous food.

Dalton says that a man in full health, taking active exercise in the open air, and restricted to a diet of bread, fresh meat, and butter, with water and coffee for drink, consumes the following quantities per day:

Meat	453 grammes or about 16 ozs.
Bread	540 grammes or about 19 ozs.
Butter or Fat	100 grammes or about 3.5 ozs.
Water	1530 grammes or about 54 ozs.

In the State hospitals of New York, the following daily *per capita* proportions have been established:

Meat, including poultry and fish.....	12 ozs.
Flour..........................	12 ozs.
Potatoes.......................	12 ozs.
Milk	16 ozs.
Sugar...	2 ozs.
Butter.........................	2 ozs.
Cheese	1 oz.
Rice, hominy, beans, peas, etc.......	3 ozs.
Tea, coffee, and one egg.	

In addition to this can be added the fruits in their season.

If we take into consideration the great differences in demands for nutrition in different persons, depending upon climate, age, size, occupation, etc., we may average 10 to 12 ozs. of carbon and 4 to 5 ozs. of nitrogenized matter (dry) as discharged from the body, and this will demand a daily consumption of between 2 and 3 pounds of solid food.

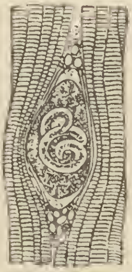

FIG. 36.—SHOWING TRICHINA SPIRALIS IN MUSCULAR FIBRES, ENCAPSULED.

An *excess* of food produces sooner or later some disorder of digestion. Most frequently dyspepsia results from the irritation of the undigested portions of food. Frequently decomposition results, which causes eructations (belching) and flatulence; also diarrhœa and constipation. Sometimes the excess results in the laying on of an increased amount of fatty tissue.

Trichiniasis is a disease which is produced in man by eating pork which has become infested with *muscle trichina* (Fig. 36). This is a fine, thread-like worm, from $\frac{1}{16}$ to $\frac{1}{6}$ of an inch in length. This worm lies coiled in the wrappings of muscular fibre. It lies in a

capsule. It is particularly liable to infest hogs, and therefore pork of any kind should not be eaten in a raw state. When trichinæ are introduced into the human body, they multiply with great rapidity, and give rise to a disease with fever, nausea, vomiting, and a great soreness of the muscles. There is also a hardness and swelling of the muscles, which are tender on pressure. It is a dangerous disease and is frequently fatal. The best treatment is prevention. As trichinæ are easily destroyed by heat, pork should be well cooked throughout. All pork should be thoroughly examined before it is sold as food. Trichinæ are easily recognized, if not with the naked eye, with a low magnifying power.

Tape-worms (*Tæniæ*) (Fig. 37) are also acquired by eating flesh of animals that contain its embryo. There are two principal varieties, the "armed tape-worm," *tænia solium*, and the "unarmed tape-worm," *tænia saginata*. In the former the head is provided with four suckers and a circle of small hooks. The hooks are lacking in the unarmed variety. The embryo of the tape-worm is taken into the body chiefly through eating pork, but it is also found in other animals. In the human body it exists only in the intestines. It is common in Europe and America, but in some countries it is universal.[1]

FIG. 37.—TAPE-WORM; ONE HALF NATURAL SIZE.

[1] In Abyssinia almost every individual beyond the nursing period, regardless of sex, is the subject of a tape-worm.

For the prevention of tape-worm, the same precaution applies as for that of trichinæ,—that is, the thorough cooking of meat. Persons who handle raw meat should be careful and cleanly, and should not eat raw pieces of meat. For this reason, cooks and meat packers are more subject to it. The use of raw grated meat, which is sometimes required in certain diseases, should always be preceded by a careful examination of the meat. White spots or streaks in the meat should always lead to its rejection.

Tuberculosis, now so very common in cattle, doubtless leads to a reproduction of the disease in the human body under some circumstances. If taken with the meat, or, if the tubercle is in the milk glands, with the milk, it may find lodgment and growth in the body. This disease is dependent upon a bacillus, known as the *tubercle bacillus* which is a microscopical germ always in tubercle, and supposed to be the cause of the disease. The same precautions govern the use of beef and milk, as were laid down for the prevention of tape-worm. A high temperature destroys the bacillus, and thus infected meat and milk can be rendered harmless by cooking and boiling.[1]

The meat from cattle that are suffering from *pleuro-pneumonia* causes carbuncle, often of a malignant character. It is claimed that the virus is not destroyed by cooking.

Frequently the meat from animals, fowls, and mol-

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[1] At the St. Lawrence State Hospital an apparatus is being constructed to Pasteurize the entire milk product. This is by raising the temperature of the milk to 165 degrees F., and keeping it at that temperature for half an hour. This destroys germ life without coagulating the proteids or otherwise changing the milk. It is then put in sterilized cans.

luscs (oysters, lobsters, etc.) which have eaten poisonous food, is the cause of sickness. There are plants that are poisonous to the human body that can be eaten with impunity by cattle, but the meat from such cattle is poisonous.

Putrid or decomposed meat is not always injurious, especially if it is sufficiently cooked. In fact, decomposition is sometimes allowed to commence in meat, in order to improve its taste for epicures. Game is allowed to "ripen" until the flesh becomes soft. Cheese that is ripe and strong is in a state of putrefaction. The Chinese are fond of eggs that have passed into a high state of putrefaction.

Sausage poisoning, caused by putrid sausages, is particularly virulent and dangerous. In short, there is no variety of animal food that may not become a source of illness under certain conditions. The safety lies in its preparation by cooking, which nearly always destroys the fungus of decomposition, and renders the food harmless.

Vegetable food is not apt to cause disease, although there are exceptions. Bread made from the flour of spurred rye, or *ergot*, when used continuously, causes a disease called *ergotism*. It acts chiefly upon the nervous system, causing dizziness, loss of vision and feeling, twitching and convulsions. It is also followed by gangrene.

Mouldy flour and bread sometimes acts as a poison, causing serious symptoms. Mouldy food of every description is dangerous to use. The remedy for these hidden sources of danger is good and effective cooking.

Food is sometimes *adulterated*, for fraudulent purposes, either to increase its bulk, improve its appear-

ance, or to give to it false strength. The various means of adulteration are so numerous that they can only be referred to here. Some adulterations are harmless, while others are harmful or actually poisonous. Thus the addition of starch to sugar and water to vinegar does no actual harm, although it is a fraud; but the addition of sulphate of copper to bread, and minerals to the coloring matter of cakes is a source of danger and a menace to health. The addition of *alum* to bread will make a good-appearing loaf of inferior or even damaged flour. It also enables bread to hold more water and increases its weight. This is a common form of adulteration. It can be easily discovered by dipping a piece of this bread in a weak solution of logwood, when it will turn purple.

Pickles and preserved fruits are made green with a salt of copper. Different forms of iron are added to cocoa, sausage, and preserved meats. The facing of tea leaves is often caused by Prussian blue and other minerals. There is scarcely an article of manufactured food that does not have some form of adulteration.

The *preservation* of food is a matter of great importance. The most ancient method of preserving food is by drying it. The germs of putrefaction must have moisture to live and propagate, and in perfectly dry food they are harmless. Drying is not well adapted to animal foods, but to vegetables and fruits it is well adapted.

The *exclusion* of air after destroying germ life by heat, is a proper and effective method of preserving all kinds of food. This is commonly called *canning*. A necessary requirement for successful canning is that all germ life must be destroyed, and that the vessel will not

admit air. Food prepared in this way, particularly vegetables and fruit, will keep for unlimited periods.

Another method is to cover the article with some impervious material to exclude the air. This, however, is not as practicable as others.

Cold is a preserver of food,[1] and the refrigerating system of preservation is growing in popularity.

Pickling is a preservative of foods, which acts by the use of chemical agents that destroy germ life and which form compounds that do not decay. *Common salt* is the foremost among these, but in the preservation of meat, for which it is commonly used, it is objectionable. It extracts the soluble substances from the meat and makes it hard and indigestible. The meat is deprived of its stimulating and nutritive qualities. *Corned beef* is an illustration.

Smoking is also used for preserving meat. The surface becomes saturated with the oil of the smoke, which is destructive to germ life.

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[1] Animals, we are told, have been found in a state of perfect preservation in the frozen earth of the Arctic regions, where they must have been buried for centuries.

CHAPTER X.

FOOD: ITS NUTRITIVE VALUE, PRESERVATION, AND DIGESTIBILITY.

THE human body is chiefly composed of *albuminous*, or nitrogenous, substances, therefore the albuminates play the most important part in the nutrition of the body.

The work of the albuminates is threefold:

(1) They contribute to the formation and repair of the tissues and fluids of the body.

(2) They regulate the absorption of oxygen and its use.

(3) Under special conditions they assist in forming fat, muscular and nervous energy, and in the production of body heat.

Therefore, the flesh of animals, being rich in albuminous substances, and easily digested, is of decided advantage as a food.

Analysis of pure muscle shows it to consist of 76 per cent. of water and 24 per cent. of solids. The albuminates amount to about 20 per cent. of fresh muscle free from fat. The analysis of beef gives 73 per cent. of water, 26 per cent. of nitrogenous matter, and 2 per cent. of mineral substances or ash. The fatter the beef, the less water it contains and the smaller the amount of albuminates.

Beef is the most used and the most nutritious of animal foods. The first quality of beef is taken from the rump, sirloin, and fore ribs; the second quality from a portion of the shoulder, buttock, and middle ribs; the third quality from the flank, shoulder, and brisket; and the fourth quality from the cheek, neck, and chin.

Veal is less digestible and nutritious than beef or mutton. It contains about the same proportion of albuminates as beef, but is not as rich in other constituents.

Mutton has a shorter fibre than beef, and is consequently tenderer. It is generally considered easier of digestion. The fat of mutton is not suited to invalids. Lamb is not as digestible as mutton.

Pork, on account of its fat, is the most difficult meat to digest.

Besides the muscular tissue and fat of animals, the organs, the blood, and even the bones may be used for food. The extract derived from long boiling of finely broken bones is very nutritious, and equivalent to its weight in meat. *Brains* contain too much fat and are difficult to digest. *Livers* are nutritious, but difficult of digestion, which is also the case with the kidneys and the heart. *Sweetbreads*, composed of the pancreas, are a great delicacy and are easy of digestion. They make a good food for convalescents. *Tripe* consists of the paunch of the ox. Its muscular fibre is easy of digestion, but its large proportions of fat unfit it for delicate stomachs.

The flesh of *poultry and game* differs from that of beef and mutton in not having fat in its muscles. It is also shorter-fibred, and hence tenderer and easier of digestion. The white-fleshed fowls particularly are

tender, well-flavored, and easy to digest. The young, well-fed chicken is the most valuable to the invalid. The flesh of game contains less fat than that of poultry. It is tender and easy to digest.

Fish afford a large and important part of human food. They vary greatly in nutritive value, in flavor, and digestibility. Fish may be divided into three classes: (1) with white flesh; (2) with red flesh, like the salmon; (3) with greasy flesh, like the eel. The last is the most nourishing but the least digestible.

As fish is digested more rapidly than other flesh it requires to be taken oftener. It therefore makes a desirable food for invalids. The red-fleshed fish have a larger proportion of fat. Fish is in the greatest perfection just before spawning. Afterwards it is thin and wasted and "out of season." Fish that have no scales are generally regarded as unwholesome. Dried, salted, smoked, or pickled fish is much less digestible than fresh. It has been customary to call fish a brain food, on account of the phosphorus it contains, but it is rather on account of its easy digestibility.

Shell-fish (lobster, crab, crayfish, shrimps, prawn) are highly nutritious, but they are not easy of digestion. In some persons they give rise to poisonous symptoms, such as nausea, vomiting, dizziness, etc. They decompose quickly and should be eaten quite fresh.

The *oyster* is the chief of the molluscs. When in season and eaten raw it is very digestible, but when cooked it is not easy to digest. The soft part of the oyster is the liver and is exceedingly easy of digestion. The hard part is the muscle and is difficult to digest. For the invalid this part should be removed. The

oyster is supposed to be easy of digestion because it consists almost exclusively of liver. The nutritive value of the oyster is not very great. It has less than five per cent. of albuminates. It would require ten dozen oysters to yield the albuminates needed in a day's ration.

Milk is a complete, or typical food, for it contains all the alimentary substances necessary for the maintenance of animal life. The only other complete food is the egg. Not only does milk form the only food for the young, but it may be employed as exclusive food in some forms of disease. In milk we have the four constituents combined in proportions necessary for health when the growth is active, but for adult food the albuminates and fat are in excess, compared with the amount of sugar.

The composition of good cows' milk is, of a hundred parts:

Water	87 parts.
Albuminates	4 parts.
Fats	3½ parts.
Carbohydrates (sugar)	4¾ parts.
Salt	¾ parts.

The albuminates consist of casein chiefly, which differs from albumen in not coagulating by heat, but it is readily coagulated by acids. The fat of milk can be separated in the form of butter. It is suspended in the milk in the form of globules. The carbohydrate is in the form of *lactose*, or *milk-sugar*. It is not as sweet as ordinary sugar. Under the influence of a ferment it is turned into lactic acid, and it is this which causes milk

to "turn sour." The potash salts are abundant in milk, and they are needed for bone formation.

Human milk (Fig. 39) has a larger proportion of sugar and fat than the milk of animals, hence, in preparing animal milk for infants, sugar should be added.

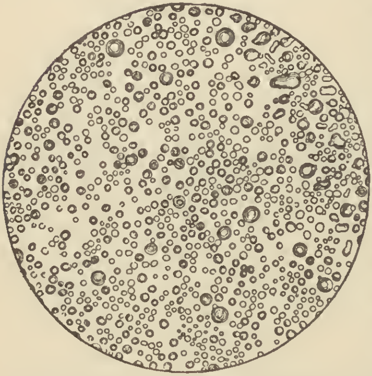

FIG. 39.—HUMAN MILK GLOBULES.

Milk of cows varies under many circumstances. Certain breeds, such as Alderneys and Jerseys, give a milk very rich in butter, while Durhams and Holsteins give a milk proportionately rich in casein. The evening milk contains a larger proportion of fat than that of the morning. A poor diet leads to a thin quality of milk. The frequency with which contagious diseases are communicated by milk necessitates great care in its selection.

If milk is allowed to stand exposed to the air, it undergoes coagulation and thickens. It is the casein of the milk that is precipitated (thrown down) by lactic acid, or the change of the sugar by fermentation. Warmth hastens this action, hence milk turns sour quicker in summer than in winter.

For *preserving* milk, various methods have been adopted. If a bottle be filled with boiled milk and sealed it may be kept unchanged for some time. Raising milk to a temperature of 165° F. for twenty minutes

and then sealing it in a sterilized vessel will keep it sweet for a long time. This process is called Pasteurizing. *Condensed milk* is the removal of the water of milk in a vacuum, adding cane sugar, and sealing in cans.

Skimmed milk is simply milk from which the cream has been removed. It is more easily digested on account of having less fat.

Buttermilk is the milk of cream left after the butter is removed. It contains but a small quantity of fat, and a large proportion of casein and lactine. It is a very nutritious fluid and easily digested, hence it is of value in feeble states of the digestive organs.

Koumiss is milk that has undergone alcoholic fermentation, by the conversion of lactose into alcohol and carbonic acid. It is a light stimulant and easily digested, and is of particular value in diseases where the stomach rejects ordinary food. It can now be bought in the market.

Butter is one of the easiest to digest of animal fats. It is made by uniting the fat globules together by churning. It is well kneaded with water to wash out the casein, and the freer it is of water the better it will keep. Salt is also added to check the decomposition of the casein.

Cheese is composed of the casein or curd of milk. It also contains more or less fat. It is ripened by keeping, when the fats increase and volatile fatty acids are developed which give it its flavor.

There are many varieties of cheese: (1) made from sour milk, and not intended to be kept; (2) Stilton and similar cheese, which contain an added amount of cream; (3) the skimmed-milk cheese, containing but

little fat; (4) the spiced cheeses, containing sage and other aromatics.

Cheese contains twice as much nitrogenous matter for the same weight as meat, and is an exceedingly nutritious and economical food. Cheese in an advanced state of decomposition is taken as a delicacy at the end of a meal, on the theory that it adds a ferment that aids digestion. There is no doubt that cheese in a moderate amount stimulates digestion.

Eggs contain all the elements of the blood. Pavy estimates that an egg weighing 2 ounces will yield 110 grains of nitrogenous matter, 82 grains of fat, and 11 grains of salt. The white of an egg consists chiefly of albumen dissolved in water. The yolk contains some fat, and is richer in solids; it is therefore more important as a food than the white. Eggs are easily digested if taken raw or slightly cooked, but are difficult to digest if cooked hard. It is said that eggs can be prepared in more than 500 different ways.

Vegetable foods present a great variety, many of them highly nutritious. They contain both albumen and fat, but the non-nitrogenous are greatly in excess of the nitrogenous substances, and occur chiefly as carbohydrates (sugars and starch). They are less digestible than animal food.

The *cereals* are the best adapted for food. They contain a large quantity of nutrition in a small space, and are easily preserved. Grain is ground into meal, and the husk is eliminated. *Wheat* (Fig. 40) contains the largest amount of nitrogenous substances (12½ per cent.); rye the largest proportion of carbohydrates (68 per cent.); oats the greater amount of fat (6 per cent.) and cellulose (11 per cent.).

The *leguminosa*, or beans, peas, etc., surpass all other seeds in the large amount of albuminates they contain. Peas and beans contain much sulphur and phosphorus, and other salts, and constitute a highly-nourishing food. They are especially useful to the active worker. They are, however, not as digestible as the grains.

The various *roots* are valuable chiefly for the amount of starch they contain. The *potato*, which is the most common tuber, when cooked makes an easily digestible food. Owing to the vegetable acids in potato, it is valuable as a preventive of scurvy.

Green vegetables as food are valuable, not as much on account of the nutritious principles they contain, which are in small amount, but because of the important inorganic salts they supply, especially the salt of potash.

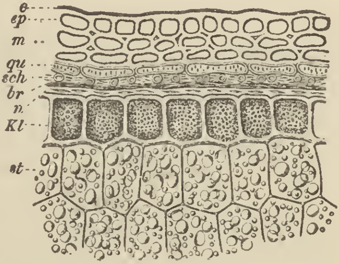

FIG. 40.—SECTION OF PART OF THE WHEAT GRAIN (MAGNIFIED). *ep*, Epidermis; *br*, *n*, Coats of the Seed; *Kl*, Gluten Cells; *st*, Starch Grains (*Landois*).

Fruits, for the same reason, are of value as a food, but possess a relatively small proportion of nutritious substance. Fruits, also, tend to promote intestinal action. When taken in excess, and not of a proper ripeness, they set up intestinal irritation.

Tea, Coffee, and Cocoa, although differing from one another in their common physical characters, agree in containing principles which are closely related. Tea

and coffee contain *thein* and *caffein*, which are identical, and cocoa contains *theobromin*, nearly the same.

The difference between *green* and *black* tea is dependent upon the time of gathering the leaves and their mode of treatment. Tea acts as a stimulant to the nervous system; removing fatigue, clearing the mind, and diminishing the tendency to sleep. It deadens the sense of hunger, and increases the power of fasting. It often relieves headache, and, taken in moderation, it proves an agreeable and wholesome beverage. On the other hand, taken in excess, it may become very injurious. The tannic acid in tea has a tendency to irritate the stomach, and persons suffering from stomach dyspepsia should refrain from tea. It is often the cause of troublesome palpitations, muscular tremors, and nervous agitation. Tea should never be allowed an invalid without the express orders of a physician.

The ordinary *strength* of tea is 4 or 5 per cent.—that is, 4 or 5 parts of the dry leaf to 100 parts of boiling water. Strong tea runs up to 7 per cent., and weak tea down to 2 per cent.

Coffee is made from the seeds of the coffee-tree after they have been roasted. The choicest coffee is Mocha or Arabian. During roasting the sugar in the berry is changed to caramel, and the volatile aromatics are developed. It should be roasted and ground only a short time before being used. It loses its volatile qualities by keeping.

The *effects* of coffee on the system are very much the same as tea, but coffee appears to have a more decided stimulating action upon the brain. It increases the secretion of the kidneys and skin, and increases intestinal movement. Coffee taken in excess produces

tremors and nervous anxiety, and an "uncomfortable feeling in the stomach." Coffee, like tea, has little nutritive value, but it seems to lessen the waste of the tissues, and in this way sustains the body under conditions of fatigue and privation.

Coffee is useful as an antidote in opium poisoning, and in intoxication. It is also useful as a heart tonic, but in invalids the nurse should always be governed by the directions of the physician,—rather as if it were a remedy, and not an article of diet.

Cocoa is more widely removed from tea and coffee in its composition. It is obtained from the seeds of a tree (*theobroma cacao*). *Chocolate* is manufactured from cocoa to which sugar and flavoring substances are added. Cocoa contains a large amount of fat, as well as albuminates and starch. Unlike tea and coffee, therefore, cocoa is a highly nutritious food. It approaches milk in its composition as a complete food. Its chief defect is in the large amount of fat it contains, which makes it apt to disagree with persons of delicate digestions.

CHAPTER XI.

DIGESTION.

THE process of *digestion* is dependent upon :

(1) the organs of digestion, viz.: the mouth, œsophagus (gullet), stomach, intestines, pancreas, and liver (Fig. 41);

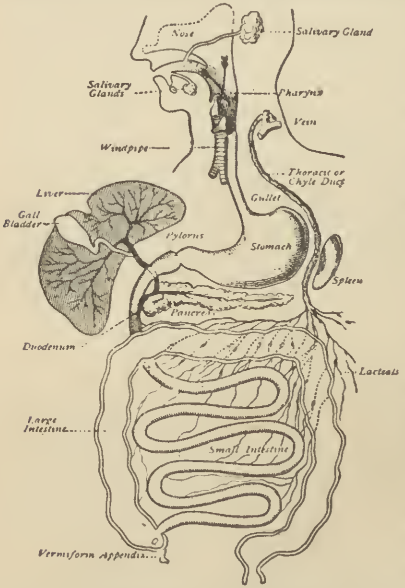

FIG. 41.—SCHEME OF THE DIGESTIVE TRACT (ALIMENTARY CANAL) AND GLANDS (*Landois*).

(2) the digestive juices, viz.: the saliva, gastric juice, pancreatic juice, bile, and the secretions of the small and large intestines.

The Mouth and its Glands.—The mucous membrane of the mouth is continuous with the skin of the lips. It is covered with minute points (papillæ), and contains many glands that secrete salivary fluid and *mucin.* The true salivary glands are in three

pairs, called the *parotid*, *submaxillary*, and *sublingual*. The *parotid* is the largest of these and lies on the side of the face, at the angle of the jaw, in front of the ear. It is connected with the cavity of the mouth by a duct (or canal) named the *parotid duct*, which opens in the mouth opposite the second molar tooth of the upper jaw. This gland is subject to an infectious inflammation called the *mumps*.

The *submaxillary* glands, next in size, are near the angle of the lower jaw just within its border. They are connected with the mouth by *Wharton's* ducts, which open into the mouth underneath the tongue.

The *sublingual* gland is situated along the floor of the mouth between the tongue and the lower jaw. It is connected with the mouth by numerous openings.

These glands consist of clusters of very small pouches (Fig. 42). The flow from them is continuous, enough to keep the mouth moistened, but the presence of food in the mouth, or the working of the jaws, excites them, and causes the saliva to flow freely. Certain drugs cause an increase in the saliva. Thus the continued use of mercury causes *salivation* or *ptyalism*, which is a copious and continuous secretion of saliva. Others, above all belladonna, paralyze the nerves of secretion, so that the mouth becomes dry. The conception of food will excite them, and "the mouth waters" at the thought of savory

FIG. 42.—DUCT AND CELLS OF A SALIVARY GLAND.

food. The emotions, particularly fear, arrest their action and make the mouth dry.[1]

The mixed *saliva*, as it appears in the mouth, is a thick, glairy, frothy fluid. Its chief purpose in digestion is to moisten and soften the food, and to assist in mastication and swallowing. It also has the property of converting starch into sugar, and, as the fluid is alkaline, it softens the muscular fibres. The particular constituent of the saliva that acts upon starch, is *ptyalin*. It will convert 2000 times its own weight of starch into sugar.[2]

Rapid eating is therefore an unhealthy practice, and deprives the food of one of the most important digestive functions. The food should be finely divided by the action of the teeth, but it is still more important to have the saliva thoroughly mixed with the food before it passes into the stomach, in order that the starch may be prepared for further digestion.

The tongue plays an important part in mastication. It keeps the food passing from between the teeth, forms it into a bolus (ball), and pushes it backwards into the pharynx (throat).

Deglutition, or *swallowing* (Fig. 43), is a complicated series of muscular movements whereby food is taken from the pharynx and is forced into the stom-

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[1] A plan at one time in vogue in Russia for the detection of criminals was the filling of the suspected person's mouth with beans, upon the assumption that, if guilty, fear would check the secretion of saliva, and if not guilty the usual secretion would swell the beans.

[2] If a quantity of boiled starch has added to it a small quantity of iodine, it will change to a blue color. If, however, the starch has been mixed with a small quantity of saliva, the iodine will not affect it, showing that the starch has been changed.

ach. There is a voluntary and an involuntary stage of swallowing. The food can be held in the pharynx, but when it once enters the œsophagus, the will has no power in preventing it from passing into the stomach.

The food is prevented from passing into the windpipe by the closure of the epiglottis.

The *œsophagus*, or *gullet*, is a muscular tube reaching from the mouth to the stomach. It has a mucous

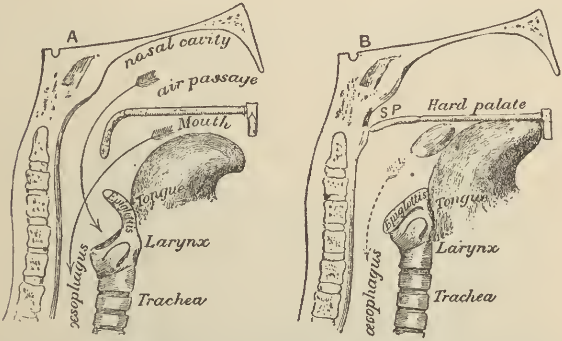

FIG. 43.—DIAGRAMS TO SHOW THE ACT OF SWALLOWING. A shows the air and food channels, and B the act of deglutition (*Landois*).

coat continuous with the mucous membrane of the mouth, which lies in folds when the gullet is empty. It also has a muscular coat and a fibrous coat enclosing it. It is very elastic.[1]

The *stomach* (Fig. 44) is a pear-shaped organ, with its convexity downwards, which lies immediately under the diaphragm and partly beneath the liver. It lies considerably higher on the left than on the right

[1] A number of instances are on record where large bodies, notably sets of false teeth, have been swallowed.

side. The left end is the larger and is called the *cardiac* end, and the right the *pyloric* end. It has two openings—the one by which the food enters through the œsophagus, called the *cardiac* orifice, and the one by which the food passes into the bowels, called the *pyloric* orifice. The size of the stomach varies greatly in different persons, and in different states of distension. When moderately filled it is ten to twelve inches long, and four to five inches in diameter. Its capacity is about five pints.

The *walls* of the stomach are thin, and have four coats, the chief of which are the mucous, or lining of

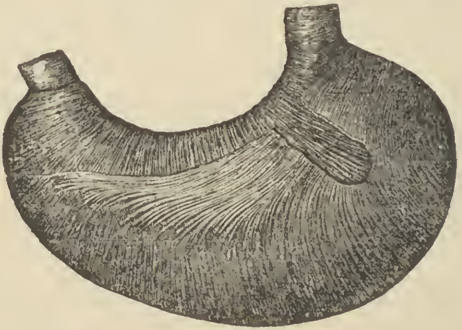

FIG. 44.—STOMACH WALLS, SHOWING THE MUSCULAR FIBRES (*Flint*).

the stomach, and the muscular coat. The latter coat has muscular fibres running two ways and crossing each other (Fig. 44), so as to contract the stomach in any direction.

The *movements* of the stomach are complicated, and are of two kinds: (1) The *rotary*, or *churning* movement, whereby the walls of the stomach in contact with the food glide to and fro with a slow rubbing motion. These movements occur periodically, every

period lasting several minutes, followed by a period of rest. By this motion the masses of food are broken down and are saturated with gastric juice. (2) The *pushing* movement, or *peristalsis*; a movement common to the whole alimentary canal. This is also periodical, and forces the contents of the stomach onward into the bowel. These movements commence within fifteen minutes after a meal and continue for about five hours.

The *mucous* coat is a smooth, soft, rather thick and pulpy membrane, which has a pinkish hue. It is closely attached to the walls of the stomach, and when the organ is empty is thrown into folds which disappear when the stomach is full.

The *glands* (Fig. 45) of the stomach are very numerous. They differ in different parts of the stomach according to their several functions. There are two distinct varieties of glands : (1) the *peptic glands*, which secrete pepsin ; and (2) *acid glands*, found especially in the greater pouch or cardiac end of the stomach. At the pyloric end of the stomach there are no acid glands.

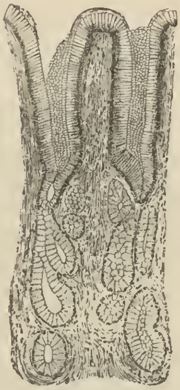

FIG. 45.—GLANDS OF THE STOMACH (MAGNIFIED).

The mechanism of digestion, to the time the food is discharged into the bowel, is very perfect. After being ground in the mill (mastication) it is taken by a tube and forced into the stomach, where it is still further ground and changed by the gastric juice. When it is in a proper condition for further changes, the pylorus, or gate into the intes-

tines, opens, and the stomach forces the food onward. This whole process is independent of the will (involuntary), and in a state of health we are not conscious of (do not feel) the digestive process.

The *gastric juice* is the fluid secreted by the glands of the stomach for the moistening and digestion of the food. By an injury causing a fistula (opening) in the walls of the stomach and abdomen, exposing its action to observation, Beaumont[1] was enabled to watch gastric digestion. During the intervals of digestion, the mucous coat is pale, and is covered with a thin mucus. On the introduction of food, it becomes red and congested with blood. Small drops of gastric juice begin to appear on the surface and increase until they trickle down in streams. This is the true gastric juice. It is curious that only the introduction of food will excite this secretion. If a tube is introduced, or other foreign matter, such as coins or buttons, the secretion is only local at the point of contact, and comparatively slight.

Natural food is therefore the proper stimulus for the stomach, and the quantity of the gastric juice is perfectly adapted to the work it has to perform. Highly seasoned articles produce a greater flow, and an abundant secretion is also excited by the vegetable bitters.

The gastric juice is acid. After the food has been changed in the stomach and forced onward, the secretion of gastric juice ceases, and the walls become pale.

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[1] A Canadian, Alexis St. Martin, received a gunshot wound in his left side, which healed, leaving a round perforation into the stomach through the abdominal walls. He was in perfect health. Through this opening Beaumont watched the process of digestion for a number of years, and gave to the world the first reliable knowledge of gastric digestion.

The *quantity* of gastric juice secreted in 24 hours depends upon circumstances, but it is estimated to be between 6 and 14 pounds.

Pepsin is the peculiar constituent of the gastric juice, and is necessary for its digestive properties. This substance is now obtained from the stomachs of animals, and is sold in the market. It is used in dyspepsia, where the stomach does not secrete a sufficient amount of pepsin. The particular function of gastric juice is to dissolve and change albuminates into a substance called *peptone.* Therefore, meats are particularly subject to change in the stomach. All but the fat and muscular substance is dissolved and changed. Of vegetable food, the nitrogenized substances are digested in the stomach.

On *fats*, *sugars*, and *starch*, the gastric juice has but little effect. Fat, or adipose tissue, is broken up in the stomach, and the fat globules are set free to be acted upon in the intestines. The starch that is not changed by the saliva, passes unchanged into the intestines. Sugar in the form of glucose is ready for absorption, and is partly taken up by the walls of the stomach, but cane sugar passes into the bowels unchanged, except a small proportion which is converted into glucose by the free acid of the stomach. Milk is one of the articles digested in the stomach with the greatest ease.

The *time* needed for gastric digestion is between two and four hours, but is greatly dependent upon the kind and quantity of food taken.

Gastric digestion is influenced by effects on the quantity and quality of the gastric juice. Gentle exercise and agreeable occupation of the mind are more favorable than absolute rest. Severe mental or physi-

cal exertion retards digestion. Bathing during gastric digestion should be avoided. Anything that tends to divert the blood from the stomach is undesirable.

Vomiting is caused by the closure of the pyloric orifice, and contraction of the walls of the stomach, and abdominal walls. The diaphragm is drawn down and fixed. A deep inspiration is made and the sudden contraction of the abdominal walls, diaphragm, and stomach forces the contents upwards.

Eructation, or *belching* of gases, occurs when the stomach is distended by gases. It frequently becomes a habit, and is largely under the control of the will.

CHAPTER XII.

DIGESTION (CONTINUED).

THE *small intestine* (Fig. 46) commences at the pyloric orifice of the stomach and after many convolutions (twistings) terminates in the large intestine. It is on the average about 20 feet in length, and becomes slightly narrower from its upper to its lower end.

FIG. 46.—LARGE AND SMALL INTESTINE AND STOMACH.

The structure of the small intestine, like the stomach, has a muscular and a mucous coat, and surrounding it a serous coat (the peritoneum). The muscular coat has longitudinal and circular fibres which give it the property of moving in every direction. Thus the progressive contraction of these fibres gives the intestines its peculiar worm-like (vermicular) movements, called *peristalsis*, which forces its contents onward.

The *mucous* coat of the small intestine presents a shaggy appearance, like the pile on velvet, owing to its

being thickly covered with *villi*. These are minute finger-shaped processes of mucous membrane, which contain numerous capillaries and each a *lacteal* vessel. They are most abundant in the upper part of the bowel. The villi are chiefly concerned in absorption, taking up the digested and prepared food in the shape of chyle, and discharging it through the lacteals into the blood circulation.

There are *folds* (*rugæ*) in the small intestine, which appear like thickened rings of the mucous membrane. By these folds the extent of the mucous membrane to which the food is exposed, is very much increased.

There are a variety of *glands* in the small intestine. The *solitary* glands are soft, white, slightly prominent bodies about the size of a millet seed, found scattered in every part of the intestine. The glands of Peyer[1] are groups of patches varying from a half to two or more inches in length. They are similar in structure to the solitary glands. Their surfaces are free from villi. There are other glands which secrete the intestinal juice and assist in the process of digestion.

The small intestine is divided into three portions: The first ten or twelve inches commencing at the stomach is called the *duodenum*. Two-fifths of the remainder is called the *jejunum*, and the remainder the *ileum*. The common bile duct and pancreatic duct open into the duodenum.

The *intestinal juice* is the secretion of the small intestine which aids in the digestion of food. It is active in converting starch into sugar, and all the starch that

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[1] These glands are those particularly affected by inflammation in typhoid fever.

escapes the saliva is changed in the intestines. It is chiefly, however, in connection with other digestive juices that it acts, and apparently has no independent function.

The *pancreas* is the long gland which lies behind the stomach and opposite the first lumbar vertebra. It is about eight inches long, one and one-half inches in breadth, and one inch in thickness, but varies greatly in size. The *structure* of the pancreas resembles that of the salivary glands, but is rather looser and softer in texture.

The *pancreatic duct* runs the entire length of the pancreas. It is usually divided at its extremity, one portion entering the duodenum with the common bile duct, and the other about an inch above.

When digestion begins, the *pancreatic juice* is secreted and is discharged into the intestine, but it is secreted only during digestion. It is strongly alkaline in reaction, and coagulates when heated. It has the property of converting starch into sugar, and cane sugar into glucose. It also has the property of changing fats; but it is the combined action of all the intestinal fluids that completes digestion, without each having singly any specific action.

The *liver* is the largest gland in the body. It measures 10 to 12 inches from right to left, is about 3½ inches thick, and about 6 inches broad. The ordinary weight is between fifty and sixty ounces. It is situated on the right side of the abdomen and fits into the diaphragm lying immediately beneath it.

The liver is divided into two lobes,—the right and left, which are divided by a deep fissure (groove). The right lobe is much larger and thicker than the left,

being about four-fifths of the whole organ. It is rounded at its border, while the left has a thin margin. The substance of the liver is solid to the feel, and is of a dull reddish-brown color.

The liver is composed of a multitude of small lobules, which are arranged like the branches of a blood-vessel. Each lobule consists of a mass of cells that are surrounded by a close network of capillaries, and the commencement of bile ducts. The bile is produced by the liver cells and is taken up by the bile ducts which surround these cells. Unlike the pancreas, the secretion of bile is continuous and is not dependent on digestion. The bile passes through the bile ducts and is discharged into the gall bladder, where it is stored up.

The *gall-bladder* is a pear-shaped sac, 3 or 4 inches long, capable of containing from 8 to 12 fluid-drachms. It is situated underneath the liver, and its large end projects beyond the border of the liver. The function of the gall-bladder is to store the bile that is produced by the liver. When digestion is not active the gall-bladder fills up, and during digestion it is emptied into the intestine.

The *ducts*, or tubes that connect the liver with the bowel are two hepatic ducts—one from each lobe of the liver—meeting with the *common duct* which enters the duodenum in connection with the pancreatic duct.[1]

The *bile* is usually of a yellowish-green color, thick and viscid. It is essential to life as an element of digestion. It is particularly in the preparation of fat for

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[1] Sometimes this duct is closed by inflammation or gall stones, preventing the bile from discharging into the intestine, and causing jaundice.

absorption that the bile is useful in digestion, but it unites with other intestinal fluids in the digestion of other food constituents. One of the chief uses ascribed to the bile is that of regulating the movements of the intestines (peristalsis) and in preventing putrefactive changes in the contents of the bowel.

The *large intestine* extends from the end of the small intestine to the external world, and is divided into the cæcum, colon, and rectum. It is about 5 to 6 feet in length. Its diameter, which greatly exceeds that of the small intestine, is from 1½ to 2½ inches. In form it differs from the small intestine, for, instead of being round, its surface is made of numerous sacs, marked off from each other by constrictions. It has a muscular coat of two classes of fibres, like the small intestine. The mucous coat is smooth and has no villi. It has glands which secrete mucus.

The *cæcum* is the largest part of the large intestine and is about 2½ inches in diameter. It is a pouch-like structure, and the ileum enters it from above. This opening is covered by two folds, called the ileo-cæcal valve. Coming off from the back and lower part of the cæcum is a narrow, tapering portion of the intestine, known as the *vermiform appendix*.[2] The cæcum is situated in the lower right-hand part of the abdomen.

The *colon* is divided into three portions, known as *ascending*, *transverse*, and *descending* colon. Starting from the cæcum, the colon ascends to the under surface

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[2] The appendix frequently has lodged in it seeds and hardened fæces, and other foreign matter, which tend to inflammation and suppuration, called appendicitis.

of the liver, where it turns to the left abruptly. This is known as the *hepatic flexure* of the colon. The transverse colon forms an arch. It passes to the left side of the abdomen, where it turns downward, forming the *splenic flexure*. The colon then descends on the left side of the abdomen and ends in the *sigmoid flexure*, which connects it with the rectum.

The *rectum* is the lowest portion of the large intestine and is situated in the back part of the pelvis, and to the left, behind the bladder. It is about eight inches in length and is smooth and cylindrical. At its upper end it is rather narrow, but below, dilates to form a reservoir or sac. At its lower part is a muscular ring, called the *internal sphincter* muscle.

Digestion is not continued in the large intestine. Those portions of the food which resist digestion pass into the large intestine and are carried forward without material change, and are known as *fæces*. Their peculiar odor is due to decomposition. The average daily quantity of fæces is 4½ ounces. Although the large intestine does not have digestive properties, it has the power of absorption, as is shown in rectal feeding. Eggs, milk, and meat extract may be taken up by the mucous membrane, and they enter the circulation in such a form as to contribute to the nutrition of the body.

The *movements* of the large intestine are much slower and more sluggish than in the small intestine. When the contents of the bowels are moved on and pass the sigmoid flexure, reflex action is excited and defecation is called for.

The following table gives the time required for the digestion of several varieties of food :

FOOD.	PREPARATION.	TIME. h.	m.
Pork	Roasted	5	15
Beef	Fried	4	00
Beef	Roasted	3	00
Beef	Broiled	2	45
Mutton	Roasted	3	15
Mutton	Boiled	3	0
Fowls	Boiled	4	0
Fowls	Roasted	4	0
Lamb	Broiled	2	30
Young pig	Roasted	2	30
Chicken	Fricasseed	2	45
Oysters	Stewed	3	30
Eggs	Fried	3	30
Eggs	Hard boiled	3	30
Eggs	Roasted	2	15
Eggs	Raw	1	30
Cheese		3	30
Codfish (cured)	Boiled	2	0
Trout	Boiled	1	30
Cabbage	Boiled	4	0
Turnips	Boiled	3	30
Potatoes	Boiled	3	30
Wheat bread		3	30
Corn bread		3	00
Beans	Boiled	2	30
Rice	Boiled	1	00
Tapioca	Boiled	2	00
Apples	Raw	2	00
Cake	Baked	2	30

There are some precautions in the manner of eating, it is well to understand. The effect of rapid eating has been referred to. It is also a harmful custom to drink too freely during the meal, as the digestive juices are thereby diluted and correspondingly weakened.

The food should first become thoroughly saturated with saliva and gastric juice, when dilution will do no further harm. Therefore drinking should be postponed until the close of the meal, or until some time after it.

Warm food digests with greater ease than cold food. It is also an aid to digestion to mix the food, thereby dividing up digestion among the several functions. A meal should not be taken in a period of great mental excitement, as strong emotions check the secretion of the digestive juices. This is shown by the dry mouth in fear, anger, and grief.

It is also hurtful to eat frequently. The digestive, like all the organs of the body, needs periods of rest. Food should not be taken oftener than once in four hours, and once in six hours would be better still. Severe exercise immediately before and after a meal should be deprecated, as it retards digestion. Sleeping after a meal is not desirable, as the stomach, like other organs, is in a sluggish condition during sleep.

CHAPTER XIII.

THE HEAT AND FORCE OF THE BODY.

Nutrition of the body is the maintenance of bodily heat and force. Its processes are attended with the development and maintenance of a bodily temperature that is more or less independent of outside conditions.

All of the functions of the body thus far described are a means directed to a single end, which is the general process of nutrition. When this is disordered, the body is in a state of disease, or *morbid.*

The introduction of new matter into the body, by digestion, respiration, etc., is required to replace the matter that is worn out (effete) and discharged from the body. All the tissues in the body undergo change, and are sooner or later replaced with new matter.[1] All of the substances taken into the body and absorbed into the blood are consumed and are never discharged from the body in the form in which they entered. They act in producing heat and force, when they are chemically changed, to be replaced by new matter.

The *body heat* is nearly the same in cold and hot climates. When the body is unable to keep up its

[1] Paley states that seven years are requisite for the renewal of the body, but an absolute time cannot be fixed, it being much less in the growing body than in the adult. Some tissues, too, change more rapidly than others.

temperature under exposure to cold, or in keeping it down under exposure to heat, death results. The temperature of the body can undergo but slight variations, and when the uniform body heat is much exceeded or diminished, it becomes disease.

The temperature of the body varies slightly, with extreme changes in climate. This is particularly true of the outside of the body, but it is doubtful if the internal organs vary much in a state of health.[1]

The blood is slightly warmer in some parts of the body than in others. The blood coming from the liver is warmer than in any other part of the body. It also cools as it passes through the capillaries.

There are also certain variations of temperature to be noticed at different times of day. There are two periods of the day when body heat is at its height, viz., eleven A.M., and four P.M., and these periods are well marked even when no food is taken. The lowest temperature is always during the night. The variations are said to amount to from 1 to 2 degrees F.

Defective nutrition and starvation have a marked effect in diminishing the temperature.

Exercise has a marked influence upon the temperature of the body. It is well known that one of the most efficient means of warming up, is to exercise the muscles. Muscular exercise increases the production of heat, but it also increases the action of the skin, which, through evaporation, passes the heat off. In exercise the heat is produced in the muscle itself.

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[1] "Currie caused the temperature in a man to fall 15 degrees F. by immersion in a cold bath, but he could not bring it below 83 degrees F. This, however, lasted only two or three minutes, and the temperature afterwards returned to a normal standard." —*Flint.*

The nervous system influences the production of heat. (This will be considered under the "Nervous System.")

Heat is probably created in nearly all the tissues and fluids of the body, by oxidation. In the internal combustion of tissue, it is shown that carbon dioxide and water are created, the former being carried to and thrown off by the lungs. It has been shown that in a muscle removed from the body, there was an elevation of its temperature when it was made to contract.

Fat is stored up in the body as a granary of supply for any deficiency in nutrition, and is an element in the maintenance of body heat. This is shown in starvation, when the fat is the first tissue to disappear. For the making of fat, it is not necessary that fat be taken as food. It can be produced from the albuminoids and the carbohydrates. In sugar-growing sections during cane-grinding time, the laborers become excessively fat from eating large quantities of sugar.

The most common method for ascertaining the temperature, is by placing the bulb of the thermometer in the axilla (the hollow of the arm) or underneath the tongue. The temperature in the axilla, in a perfectly healthy adult man, has been found to range between 97.7° and 99.5° F.[1] Therefore the standard has been fixed at the average, 98.4°.

A *thermometer* is a column of mercury in a vacuum, with a scale marked upon the tube. The temperature of the body can be taken in various ways, as before

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[1] The symbol F. stands for Fahrenheit, which is the thermometer scale devised by a German scientist of that name, and which is a scale designating the freezing point of water at 32 degrees, and the boiling point at 212 degrees.

stated, and by introducing the bulb of the thermometer in the rectum. A sensitive thermometer will record the temperature in ten minutes in the axilla, and in five minutes underneath the tongue or in the rectum. *Self-registering* thermometers have the top portion of the mercury arranged to stick at its highest point, thus recording the maximum temperature. The ordinary clinical thermometer has a scale running from 95° to 108° F.[1]

Fever is a disorder of the body heat. The bodily mechanism that regulates the formation and expenditure of heat—in other words, the heat balance—is disordered. In fever the body is incapacitated for work. The energy that would naturally be force, is changed into heat.

In fever there is an increased wasting of the tissues (metabolism). More fuel is consumed, corresponding to the amount of heat produced. The vital energy we call strength, or force, is converted into heat.

We may now understand what is called the *potential energy* of the body. The body nutrition has a certain value, which may either be expended in heat or in work. In the resting condition the "potential energy" is changed into heat, and in the workman it is transformed into work, or force.[2]

Inflammation increases the heat at the part affected, sometimes without increasing the general heat of the body. When this occurs the heat of the part does not

[1] The centigrade scale is sometimes used. It was invented by Anders Celsius, a Swedish astronomer. He divided his scale into 100 parts.

[2] The body may be likened to a steam-engine. If the steam is not used, it radiates (gives out) all its heat. If the engine works there is less heat, but more force.

exceed that of the blood, but is due to the increased amount of blood in the part. In this condition the disease is known as *local*. If the general heat of the body is increased, it is *constitutional*.

The *lowering of the temperature* of the body has the effect of reducing metabolism, or the change of tissue. There is both mental and physical dulness. This is shown in the tendency to sleep of the freezing person, and the difficulty of moving. It is also shown in the *hibernation* of some warm-blooded animals. At a certain season, the body temperature is reduced, the heart beats very slowly, and the animal is almost in a state of death. There is little or no tissue-change (metabolism). But when the body is again exposed to warmth, tissue-change begins and the animal becomes alive and active again.

There are very few constitutional diseases of an acute character in which the temperature is not disturbed. The body heat is usually increased. When the thermometer shows a temperature of over 99.5° F., it is called *fever*, or *pyrexia*. Ordinarily, with a rise of temperature there is an increase in the heart beats and the number of respirations.

CHAPTER XIV.

THE NERVOUS SYSTEM. THE BRAIN.

The *Nervous System* is distinct from all other systems and organs in the body.

It consists of a central part, and of fibres connecting this centre with all parts of the body.

The *central part* is a series of organs called the *cerebro-spinal* centre, and consists of the *brain* and *spinal cord*.

The *nerves* are in the form of cords, and connect the brain and spinal cord with the muscles, skin, and all the organs of the body.

The *substance* of the nervous tissue is of two kinds —the gray and the white. The gray substance is only in the nerve centres, and the nerves are wholly composed of white substance.

Under the microscope the nervous substance is seen to consist of two different structural elements, viz., *fibres* and *cells*. The fibres are found in the nerves, and also make up the greater part of the nerve centres. The cells are confined to the cerebro-spinal centre.

Besides the *cerebro-spinal* system, there is the *sympathetic*, or *ganglionic*, system. The former is particularly distributed to the skin, muscles, and organs of special sense, and has to do chiefly with sensation and motion. The latter is distributed to the vital organs,

blood-vessels, and that portion of the body of which the motions are involuntary.

In a general sense the nervous system regulates the functions of the body, and makes the several parts of the body harmonize with each other. It regulates and

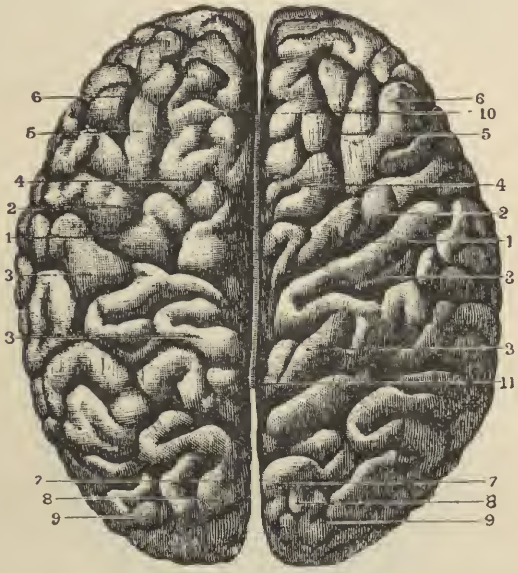

FIG. 47.—UPPER SURFACE, OR CONVEXITY, OF BRAIN (*Gould's Dictionary*). 1, fissure of Rolando; 2, ascending frontal convolution; 3, parietal convolution; 4, 5, 6, frontal convolutions; 7, 8, 9, occipital convolutions.

governs all the processes of organic life. The nervous system makes the difference between animal and vegetable life. The functions we have previously considered are known as *vegetative* functions, because they are common to all life.

The *cerebro-spinal* centre is made up by the *brain* and *spinal cord*.

The *Brain*, or *encephalon*, is a great mass of nervous tissue placed within the *cranium*, or *skull*.

It is divided into the *cerebrum* or *fore-brain*, the *cerebellum* or *hind-brain*, and the *medulla oblongata*, which is the union of the brain with the spinal cord. These

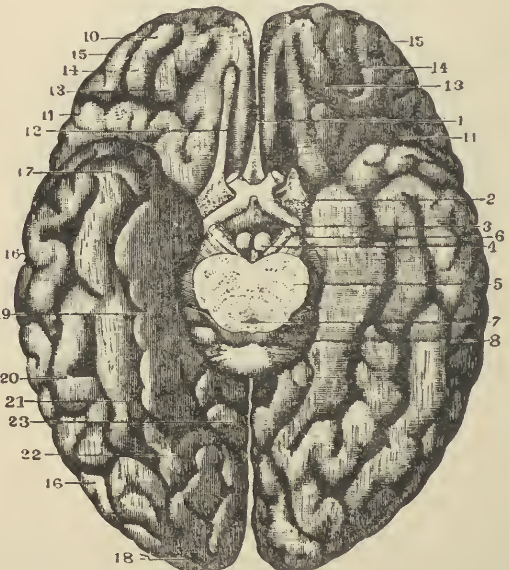

FIG. 48.—BASE, OR LOWER SURFACE, OF BRAIN. 1, corpus callosum; 2, optic nerves; 5, pons Varolii; 6, third nerve; 10, lower surface of frontal lobe; 12, olfactory nerve.

parts are all intimately connected with each other and with the spinal cord. The brain is also divided into two parts by a deep fissure, into the *right* and *left hemispheres*.

The weight of the brain is variable, but averages 50 ounces in males and $44\frac{1}{2}$ ounces in females. The proportionate weight of the cerebellum to the cerebrum, is as 1 to $8\frac{1}{4}$.

The *surface* of the cerebrum is marked by *fissures* (grooves) and *convolutions* (Fig. 47), which serve to increase the extent of surface. The *sulci* (grooves) average about an inch in depth. On the surface of the cerebrum is located the *gray matter* which is from

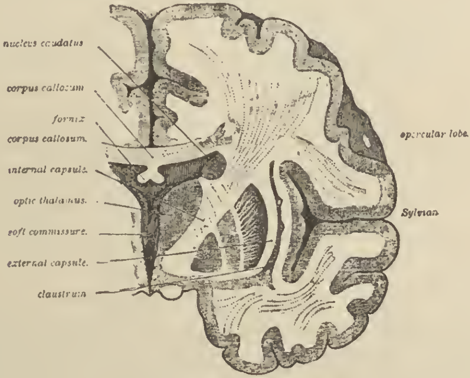

FIG. 49.—SECTION OF BRAIN SHOWING THE GRAY MATTER, OR CORTEX, AND THE DIRECTION OF FIBRES.

$\frac{1}{12}$ to $\frac{1}{8}$ of an inch in thickness. The gray substance contains cells, which are connected together by fibres, and have fibres extending from them, which, collected together, make up the nerves (Fig. 49). This applies to the gray matter in all the nerve centres. The gray matter on the surface of the cerebrum is called the *cortical substance* or *cortex*.

The *cortical cells* (Fig. 53) vary in their appearance

in different parts of the cerebrum, and in different layers of the cortex. The superficial cells represent the functions of human intellect,[1] while the deeper cells have to do with the nervous functions common to animal life. Underneath the gray matter the substance of the brain is white, and is chiefly composed of fibres coming from the cortical cells.

At the *base* of the brain are several *ganglia*, or collections of gray matter. Many of the fibres coming from the cortex pass into these ganglia, and others pass directly into the spinal cord. Some fibres pass into the hind-brain. Some pass from one to the other side of the brain. The different parts of the brain are, therefore, intimately united.

It has been found by experimentation on animals, and by injuries to the brain, that certain convolutions have distinct functions. There is a centre for the movement of the arms, one for the movement of the legs, and one for speech, etc.

For convenience of study the *cerebrum* is divided into sections called *lobes*. There are four lobes, called the *frontal*, *parietal*, *occipital*, and *temporo-sphenoidal*. These are separated by the larger furrows (sulci). Thus, the *fissure of Sylvius* which separates the frontal lobe from the rest of the cerebrum is very deep, and contains the middle cerebral artery which supplies a large portion of the brain.

The *fissure of Rolando* is another deep furrow which separates the frontal lobe from the parietal lobe, and

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[1] In cases of insanity, where the intellectual faculties are largely destroyed, these cells are found to be degenerated. The development of these cells corresponds to the development of the mind and bodily functions.

extends from the top of the hemisphere obliquely across it.[1]

The *cerebellum* (Fig. 50), or *hind-brain*, or *little brain*, consists of two lateral halves, united together and with the cerebrum by a mass of fibres. The surface is gray matter and its interior chiefly white matter. Unlike the cerebrum it has no convolutions, but it is crossed by a large number of ridges which dip down into the white substance at different depths, making a foliated (tree-like) appearance, called the *arbor vitæ*.

FIG. 50.—VERTICAL SECTION OF CEREBELLUM, SHOWING ARBOR VITÆ.

The *function of* the *cerebellum* is to co-ordinate (harmonize) the movements of the body. Animals in which the cerebellum has been removed cannot retain their equilibrium—in other words, it is impossible for them to make regular movements. Thus standing, which requires the exact contraction of certain muscles, is dependent upon the cerebellum to regulate such contraction, and this is true of all action—walking, running, writing, etc.

The *medulla oblongata*, sometimes called the *bulb*, connects the spinal cord with the brain. It is appar-

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[1] All the fissures and convolutions have names which it is unnecessary for the student to learn. The teacher should have a model of a brain, that can be taken apart in giving this lesson.

ently continuous with the spinal cord. It is composed of white and gray matter, and contains a number of important nerve centres. As the nerve fibres pass down from the brain into the medulla, they decussate (pass from one side to the other), so that the brain cells on one side distribute their fibres to the opposite side of the body. This is shown in disease of the brain, which always affects the side of the body opposite to it.

The nerve centres for swallowing and vomiting are contained in the medulla. There are also centres for the action of the liver, and the secretion of sweat and saliva.

The most important function of the medulla is the centre it contains for respiratory action. If the medulla is destroyed in animals, breathing stops at once. If the spinal cord is severed below the medulla, breathing continues.

CHAPTER XV.

THE BRAIN (CONTINUED), SPINAL CORD, AND NERVES.

THE brain is surrounded by *membranes*, that serve to carry the blood-vessels and protect its surface, named *meninges*.

The *meninges* are: (1) an external, strong, fibrous membrane which lines the interior of the skull, called the *dura mater;* (2) a membrane which closely covers the brain, made up of blood-vessels called the *pia mater;* and (3) an intermediate, thin, tissue-like membrane called the *arachnoid*.

The *dura mater* is a strong, white, fibrous tissue, that lines the interior of the cranium and that is analogous to the peritoneum. It has two layers which separate and form canals, called *sinuses*, through which the venous blood is carried. The dura sends inward three strong membranes, which form partitions that separate and support the cerebrum and cerebellum, and the two sides of the brain from each other.[1]

The *pia mater* is a delicate vascular membrane which covers the entire cortex of the brain, dipping down in the sulci or furrows on the surface. The pia contains

[1] The dura is subject to inflammation called pachymeningitis, and to injury. In insanity this membrane is frequently affected.

great numbers of blood-vessels, which divide in it before entering the brain.

The *arachnoid* is a very delicate membrane that covers the pia. The space between it and the pia contains a considerable quantity of fluid.

FIG. 51.—SECTIONS OF THE SPINAL CORD. Upper figure through cervical, middle figure through dorsal, and lower figure through lumbar regions.

The membranes of the brain are subject to a serious and often fatal inflammation called *meningitis*. *Cerebro-spinal meningitis* is sometimes epidemic. It is a most terrible disease and is usually fatal.

The *spinal cord* or *spinal marrow* occupies the spinal canal, and is continuous with the brain. Its length is fifteen to eighteen inches, and its weight is about an ounce and a half. Its general form is round, but it is slightly flattened in portions.

The *substance* of the cord is composed of white and gray matter, which, unlike the brain, has the white matter upon the outside. The cord has a deep fissure on both its front and back surfaces throughout its entire length.

The arrangement of the gray matter in the cord is in the form of the letter H (Fig. 51). The horns are called *cornuæ*, and the part uniting the two sides is called the *commissure*. In the centre

of the commissure is a canal which communicates with the brain.

The *white substance* of the cord is composed chiefly of nerve fibres, which are separated in bundles that make up the "columns" of the spinal cord.

The spinal cord is surrounded by membranes which are similar to, and continuous from, the membranes of the brain. The dura of the cord, however, lies loose, and is not attached to the bone as it is in the skull.

The fibres in the spinal cord, besides being continuations of the fibres from the brain, connect the nerve roots of the posterior with the anterior roots of the cord. (See chapter xvi.)

The nerve-centres in the spinal cord regulate muscular movements. If an animal has the spinal cord divided near the brain, it loses all sensation and all voluntary motion—that is, the will has no further control. If, however, the skin is irritated (pinched or burned), the animal will move away. This shows that the spinal cord has the power of regulating movements. The gray matter of the spinal cord has the property of "generating motor impulses."

The *nerves* are formed of nerve fibres already described, which are collected together and bound up in bundles, wrapped with a strong, fibrous *connective tissue*.

The cerebro-spinal nerves are connected by one extremity to the brain or spinal cord, and this is called the *root*. The fibres of the nerves may be traced for some distance in the substance of the nerve-centre. If the nerve fibres could be followed, it would be found that they start from the gray substance, or cells. That is, in fact, the only way that the fibres can start. A

nerve cell has a prolongation which extends into a fibre, and a collection of these fibres makes a nerve.

As nerves approach their termination, or endings, they again divide into branches. The subdividing is continued until they are reduced to the original fibres, which are distributed to the cells of the tissues.

The *cerebro-spinal* nerves present two kinds of fibres: (1) the sensory fibres, in which the impulse is from the outside towards the nerve centre; (2) the motor fibres, which conduct the impulses from the brain and spinal cord to the muscles, and excite action. There are also the nerves of *special sense*, with impulses towards the brain.

The *sensory* nerve fibres are independent of each other, and if a fibre is irritated in any part of its path to the centre, it refers to its ending. A familiar example of this is in limbs that have been amputated. Irritation of the ends of the nerves at the stump will feel as if the fingers or toes were irritated. Another example is striking the ulnar nerve at the elbow (crazy-bone), which causes a tingling of the ring and little finger.

The *motor* nerve fibres carry a force, which we do not yet understand, from where it is generated in the nerve centres outward to the muscles, which causes them to contract. If the nerve to any part is cut in two, the muscle is said to be paralyzed and will not act; but if a current of electricity is passed through the external part of the cut nerve, it causes the muscles to contract. The nerve fibres are independent of each other and only act upon the part they supply.

There is no apparent difference between a sensory and a motor nerve fibre, but their functions are always distinct. A sensory nerve will never conduct an im-

pulse outward, or a motor nerve will never carry an impulse toward the brain. Both classes of fibres are carried side by side in the same nerve sheath.

The nerve current is very rapid. The rate in the human subject is estimated to be 111 feet a second. This varies, however, in different persons and in different states of the body. The expression "to act quickly" has a physiological meaning, and persons differ very much in the time occupied to perform an action after a given signal. In some forms of brain and nerve disease, the nerve impulses become very slow.

The *sympathetic nervous system*, like the cerebro-spinal, is composed of centres, or ganglia, and nerves.

The *ganglia* contain nerve cells which are quite similar to the cells in the cerebro-spinal centres, and the fibres are also nearly identical. The ganglia make a continuous chain on either side of the body. These ganglia receive nerve fibres from the cerebro-spinal system.

The sympathetic fibres are distributed to mucous membranes, the skin, involuntary muscles, and particularly to the muscular coat of arteries.

The general properties of the sympathetic system is the control of the organs of nutrition. They contain no power of sensation except that derived from their connection with the cerebro-spinal system. Secretion and excretion, circulation and absorption, are governed by the sympathetic ganglia and nerves.

If the sympathetic in the neck be divided, the temperature upon that side of the head will be increased, and the supply of blood to that part will be very great. If the sympathetic nerve supplying a secreting gland like the parotid is cut, secretion goes on continuously and rapidly without any check.

CHAPTER XVI.

THE NERVES AND NERVOUS MECHANISM.

Vaso-Motor Nerves.—There are certain nerves that control the size of blood-vessels. They restrain and regulate the muscular walls of vessels, and in this way control the supply of blood to the several organs and tissues of the body. They belong to the sympathetic system of nerves, but have distinct properties and are called *vaso-motor nerves*. These nerves are also connected with the cerebro-spinal system, as the emotions affect their action.[1]

It has been found that the nutrition of different parts of the body may be profoundly affected through the nervous system. It is therefore assumed that there is a distinct function of the nervous system governing nutrition, and this is called the *trophic* function of nerves. An illustration is bed-sores and suppuration of different parts of the body, in degeneration of nerve centres following paralysis.[2]

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[1] Blushing, as the result of emotional feeling, is caused by the capillaries of the cheeks dilating, and thus allowing more blood to the surface.

[2] Insane patients, especially those suffering from organic dementia, contract bed-sores notwithstanding the greatest care. Also in the last stages of general paralysis, any pressure on the surface may cause a breaking-down of the skin and tissue beneath. This shows a trophic disturbance of the nervous system.

Reflex action (Fig. 52) is a complete arc, or a circuit of a nerve current beginning with the termination of a sensory nerve, passing through a nerve centre, and ending at the termination of a motor nerve. It may be likened to the sending of a telegraph message to an office by one wire and its return to the same point over another wire after passing through the office.

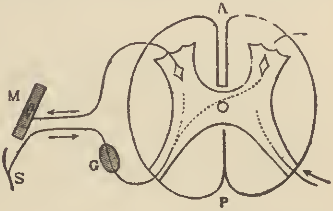

FIG. 52.—DIAGRAM SHOWING A REFLEX ARC. S, skin; M, muscle; A-P spinal cord; arrow showing direction of current (*Landois*).

Automatic reflex action is the completion of a circuit, without the intervention of the will. If the hand accidentally touches a hot surface it is suddenly withdrawn, before the person can comprehend it. The muscles of the arm have acted automatically. In the case of a decapitated frog, pinching the foot causes the muscles of the leg to contract.

A simple automatic reflex act has the spinal cord for a centre. In the case of the burned hand, the irritation at the periphery (outer end) of the sensory nerve sends an impulse to the spinal cord, through which it is conducted, and it in turn sends another impulse through the corresponding motor nerves to the appropriate muscles, which contract and withdraw the hand.[1]

There are certain automatic reflexes that are used in

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[1] The teacher can give many illustrations showing simple reflex acts involving different parts of the body.

the diagnosis of nervous diseases.[1] One of the simplest is the tapping of the tendon underneath the knee-pan, which causes the foot to kick out, without the exercise of the will. This would occur if the person operated upon was asleep or unconscious. Another reflex is the movement that occurs upon tickling the soles of the feet.

An inherited automatic reflex is the sucking by a new-born infant when anything is put in its mouth. Instances of this kind are so familiar that they need not be repeated.

Certain *drugs* produce an excitability of the nervous system, and increase the reflex action, so that the least irritation causes a muscular contraction. *Strychnine* is one of these drugs, and an animal poisoned by strychnine will be thrown into spasms by the slightest touch.[2]

Inhibition, or the *inhibitory property* of the nervous system, is the power of restraining muscular and secretory action. It is the *inhibitory* quality of the nervous system that controls and regulates nutrition, the circulation, etc. It keeps the involuntary muscles at just the right tension. In a state of health, the blood-vessels are kept at the proper size, the heart's action is restrained so as to make it beat with regularity, and this applies to all the functions of the body.

There are nervous mechanisms that suppress, or *inhibit*, the reflexes. Reflexes may be restrained, or inhibited, by the will. An example is the keeping of

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[1] See appendix for table of reflexes.

[2] Convulsions, especially of young children, the result of indigestion, are reflex in character. So are the contractions in tetanus, or "lockjaw," and in hydrophobia.

the eyelids open when the eyeball is touched. When the will is not exercised, the lids will close instantly. The suppression of reflexes is possible only up to a certain point.

Reflexes are divided into *superficial* and *deep* reflexes. The superficial are *skin* reflexes, and the deep are *tendon* reflexes. The physician can ascertain the condition of the entire length of the spinal cord by studying these reflexes. If the nurse in attendance upon the patient observes any unusual reflex, it should always be reported to the physician.

Diseases of the spinal cord may destroy the reflexes, or when the disease is such as to irritate the spinal centres, it increases them. Thus, in some forms of spinal disease, tapping the knee will cause the foot to fly out violently. In other diseases, particularly when the reflex path is broken or destroyed, the foot does not move when the knee is tapped.

The spinal nerves, or the nerves coming from the spinal cord, are thirty-one pairs. Each nerve arises from the spinal cord by two roots, an anterior and a posterior. The anterior root contains only motor fibres, and the posterior contains sensory fibres. Outside the spinal cord the two roots unite to form one nerve. The spinal nerves supply the limbs and all the body in front of the spinal cord.

The spinal nerves from several vertebræ unite to form the large nerves supplying the limbs. The great sciatic nerve, the largest nerve in the body, is an instance. It supplies the thigh and leg. The spinal nerves have the property of sensation and motion, and have no special function.

The *cranial* nerves, unlike the spinal nerves, have

special functions. Some are nerves of special sense, some nerves of motion, and others nerves of general sensibility. There are twelve pairs of cranial nerves, that have their roots in the brain. The most important is the *pneumogastric*, a great nerve that arises from the medulla and supplies the heart and muscles of respiration. If this nerve is divided, death results.

The *facial* nerve supplies the muscles of the face, and it has been called the "nerve of facial expression." If paralysis upon one side occurs, the angle of the mouth is drawn down and to the opposite side, the eye is widely opened and does not close in sleep, and the face on that side has a peculiar expressionless appearance. If the patient attempts to smile, the distortion is much increased. The same results would occur if the facial nerve on one side was divided.

CHAPTER XVII.

FUNCTIONS OF THE BRAIN: MIND; CONSCIOUS LIFE.

THE power of *thinking*, *feeling*, and *willing* resides exclusively in the brain. All that constitutes *mind* has its seat in the brain. These are the highest functions of the brain, and are known as *psychical* (from the Greek *psyche*, soul or mind).

In the brain, also, are contained the centres of special sensation, the centres for motion directed by the will. It is a complex organ, having many duties, and bearing a close relationship with them all.[1]

The *gray substance* (Fig. 53) upon the external surface of the cerebrum, known as cortical (the cortex), is capable of creating (generating) motion (motor im-

[1] "Our brains are seventy-year clocks. The Angel of Life winds them up once for all, then closes the case, and gives the key to the Angel of Resurrection. Tic-tac! Tic-tac! go the wheels of thought; our will cannot stop them; they cannot stop themselves; sleep cannot stop them; madness only makes them go faster; death alone can break into the case, and seizing the ever-swinging pendulum, which we call the heart, silence at last the clicking of the terrible escapement we have carried so long beneath our wrinkled foreheads. Now, when a gentleman's brain is ill-regulated or empty, it is, to a great extent, his own fault, and so it is simply retribution that, while he lies slothfully or aimlessly dreaming, the fatal habit settles on him like a vampire and sucks his blood, fanning him all the while with its hot wings into deeper slumber or idler dreams."—*Holmes's "The Autocrat of the Breakfast Table"*

pulses) of the kind known as voluntary. It also receives sensory impressions, including the impressions of the special senses, and it interprets them (consciousness) and records them for future reference (memory), and in addition has the power of generating operations that are known as *mental operations*, or *intelligence*.

FIG. 53.—GRAY MATTER OF THE CEREBRAL CORTEX (HIGHLY MAGNIFIED), SHOWING THE DIFFERENT LAYERS OF CELLS.

The part of the brain which is the seat of intelligence is not known. The latest hypothesis is that it is located in the whole surface of the cerebrum, particularly in the uppermost cells of the cortex. The diseases of the brain have given more information upon this question than experimentation. Take the common form of insanity, for instance, known as *general paralysis*, or paresis. This is, substantially, a disease of the rind of the brain; that is, the earliest changes show that the circulation at the very surface of the brain is disturbed, and the intellectual disturbance corresponds with the extent of such change in the vessels. When the degeneration extends deeper into the cortex, then motion is affected.

Another evidence that the mind is not located in any one portion of the brain is, that portions of the

brain can be removed without any very serious impairment of the intellect.

The importance of the brain increases in animals as they ascend in grade. It is possible to remove the cerebrum in frogs and the lower grade of animals and yet keep the animal alive. This is not possible in the higher order of mammals. In man, also, the relative weight of the cerebrum to the brain as a whole, and to the body, is much greater than in animals, showing its greater importance.

The brain, as previously shown, has two elements—cells and fibres. The fibres act only as a means of communication from one cell to another, and between the cells and the organs and tissues of the body; like a telephone circuit which has its several offices (cells) connected with each other by wires (fibres).[1]

The cortex contains millions of these cells (Fig. 53). When an impulse from one of the sense organs—sight, touch, hearing, etc.—is carried inwards to the brain, as it passes through the basal ganglia it is selected and classified and sent to its proper cell in the cortex. This cell is excited by the impulse, and it sends out other impulses and other cells are excited, and in this way mental operations are created. If a series of motor cells are excited, they send out an impulse which causes muscular contraction, and motion is the result.

Education is the creation of new paths of association between brain cells; so that a memory of one thing will excite a series of cells recalling other things, and

[1] Bain gives a total of twelve hundred millions of cells in the gray covering of the hemispheres. He estimates that every cell is united by an average of four fibres each.

by the combination an idea is created. The more vigorous the physical condition of the cells, the better are the thinking powers, so that a man in the prime of life is at the height of his mental as well as physical vigor. In old age, as the body begins to wear out, the brain cells show impairment in loss of memory, childishness, etc. The same is shown after deprivation of food and in extreme fatigue.[1]

A function of the brain that is of great importance is its *automatic activity*. We have seen how the spinal cord acts automatically in the automatic reflexes. The brain has the same property, although in the latter it is closely related with consciousness. Take, for instance, the act of knitting. Until it is once learned it requires all the concentration of attention and will to perform it successfully. When it is once fully acquired, it can go on automatically, without the attention of the operator. Thus it is with all the acts of the body. The cells of the brain retain and repeat experiences. "They live, they feel, and they remember."

It is the higher functions of the brain concerned in *feeling*, *willing*, and *knowing* that we call *conscious life*, or *the mind*. It is this property of the brain that raises man above the animals. The cortical cells are a storehouse in which are stored up the experiences of life (memory), and the sifting and grouping of these experiences, making new combinations, is thinking.

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[1] Sir Henry Holland relates that on one occasion he descended, on the same day, two deep mines in the Hartz mountains, remaining some hours in each. In the second mine he was so exhausted with lack of food and fatigue that his memory utterly failed him,—he could not recollect a single word of German. The power came back after eating food and wine.—*Bain*.

Every sensation is first received through a sensory fibre, which carries the impulse to a brain cell. This is called *objective* sensation—that is, from without. Then, brain cells may be put in a state of activity without any stimulation from a sensory fibre, and this is called *subjective* sensation. This is illustrated in the hallucinations of the insane. A stump appearing to a person as a lion, he has an illusion, which is objective, there being an object ; but if he sees a lion where there is nothing to see, it is a hallucination, or a *subjective* sensation, a stimulation of the brain cells without any external stimulus.

The following chart (Fig. 54) will give a fair comprehension of the mechanism of nerve paths. The sub-cortical centres are those that relate to the maintenance of nutrition, or organic life. This nervous action is closely related to all mental operations, and the body and mind are inseparable. It will also be seen, that like the automatic reflex, all nervous action forms a reflex circuit. There is a sensory fibre, a nerve centre (cells), and a motor fibre.

Sensation is the feeling that is derived from the special senses, and it is through them we gain our notions of the external world.

The *emotions* are also feelings—of joy and sorrow, love and hatred, fear, etc. The emotions are largely dependent upon the more primary sensations. We see a beautiful object, we long for it, and then possess it and have a feeling of joy, the latter originating from the sense of sight.

An *idea* is a copy of a sensation. We see the sun, and then by closing our eyes we can think of it—picture it. The feeling that exists without the sense

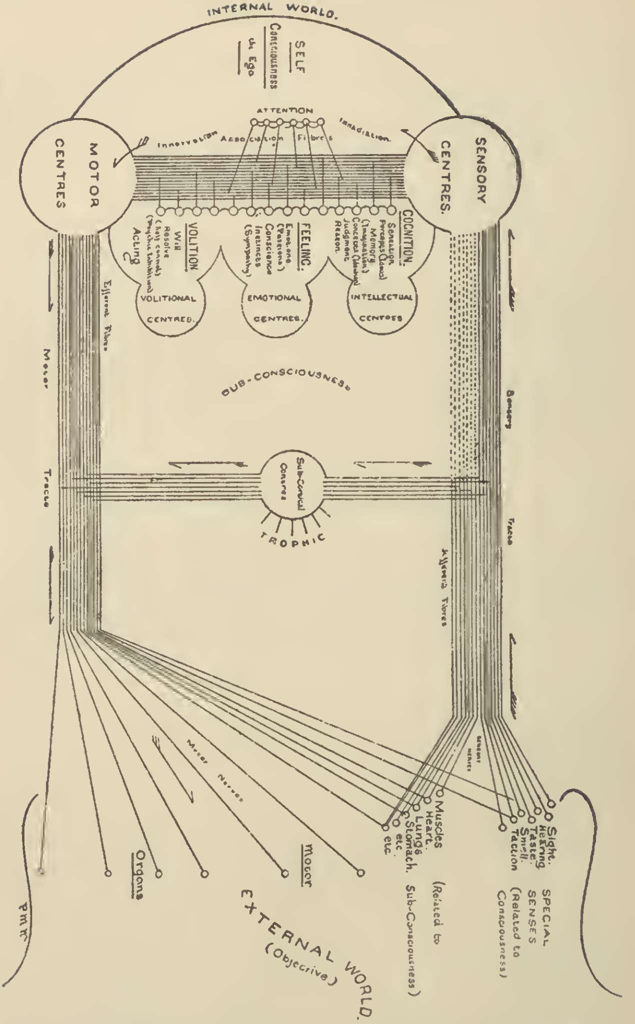

FIG. 54.—DIAGRAM REPRESENTING NERVOUS ACTION FROM EXTERNAL IRRITATION, SHOWING THE REFLEX CHARACTER OF ACTS.

organs is an idea. We have ideas of sight, of touch, etc.

Perception is the association of a sensation with the memory of other sensations that gives us a knowledge of it. There are *sense perceptions* or *external perceptions*, and *self-consciousness* or *internal perceptions*, and *intuition* or the knowledge of first truths. In a dark room we place our hands upon an apple, and by touch we bring to our "mind's eye" the appearance of the apple. This is a *percept.*

The power we have in ourselves to do, or to act, and to forbear from doing, or not to act, is called *will* or *volition.* With the exception of involuntary or automatic acts, every motion of our bodies is caused by the action of the will. It is a distinct and well-marked function of conscious life, or mind, and it can be disordered alone, without any disturbance of other mental operations.

An act that has been performed under the direction of the will for the first time, may subsequently become automatic. Nervous paths are formed, that are complex in character, which require only stimulation to carry on the full act automatically; for example, a person playing a well known piece upon the piano while holding a conversation or having the attention wholly diverted.[1]

Somnambulism, or *sleep-walking*, is a state of activity of the body during sleep and unconsciousness, and is an instance of automatic acts. A person in this condi-

[1] The riding of a bicycle, which to the beginner is a most complicated and difficult series of movements, to an adept requires no more attention than the act of walking, and is performed automatically.

tion will do acts that at first required all the concentration of will and attention.[1]

It has been found that certain parts of the brain control certain movements. There is a *speech-centre*, for instance, that controls the movements in spoken language. It is located in the left frontal lobe of the cerebrum, but in left-handed persons it has been found to be upon the right side. When this portion of the brain is diseased, speech is entirely lost, and the patient is said to have *aphasia*. This is quite different from *aphonia*, which is merely a loss of voice from some disorder of the vocal chords.

Speech requires a knowledge of the meaning of words, and then the necessary action to express them. Words may be spoken or written, both requiring the same mental operation, but quite different muscular movements. One or more of these conditions may be absent. *Aphasia* is a loss of verbal expression generally, either by speaking or writing. There are some cases in which written words convey no idea, while spoken words are understood. This condition is called *word-blindness*. The inability to write is called *agraphia*, and the loss of memory of words is *amnesia*. In severe cases of hemiplegia (paralysis), there is usually *aphasia*.

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[1] Insane patients whose mental faculties have nearly disappeared, are frequently able to do work connected with their previous trade and occupation wholly out of proportion to their power of will.

CHAPTER XVIII.

SLEEP AND SLEEPLESSNESS (INSOMNIA).

ONE-THIRD of each day is, or should be, passed in *sleep*. It is the means by which nature recuperates the nervous system, and during the period of healthy sleep the entire body is in a state of complete rest, except for the muscular acts of circulation and respiration.

There is no more severe torture than depriving a person of sleep, and it has been used as a means of torture. After a certain limit, sleep will occur under almost any conditions. Severe muscular exercise may even be continued during sleep. Men have been known to sleep while walking, in the saddle, and during the din of battle. The brain may be in a condition of absolute repose during sleep. As a rule, the body is also in repose, although change of position may be made without awakening. The special senses are blunted, although general sensibility is retained.

Reflex action is not suspended, which shows that the nervous centres below the cerebrum remain unchanged. Thus, the leg will be drawn up when the sole of the foot is tickled, etc., without awakening the sleeper. Ordinary sense-impressions are not noticed in a state of profound sleep, but when they are extraordinary the sleeper is aroused. This is a feature of

difference between natural sleep and diseased sleep (coma).

During sleep the *blood circulation* in the *brain* is lessened. Whether this is a cause or a result of sleep, is not fully settled.[1] That a diminished supply of blood to the brain is a cause of sleep, is shown by compressing the arteries that feed the brain. In this way, immediate and profound sleep can be produced.

When the cells of the brain become fatigued, the sympathetic nervous system that controls the walls of blood-vessels (vaso-motor), causes the vessels to contract, thus reducing the supply of blood to the brain, and sleep results. It is a provision of nature that beautifully represents the principle of self-protection.

Although sleep is required by the exhaustion of the brain elements, there are certain conditions that favor it. The absence of sense-impressions—darkness, silence, etc.—promotes it. Assuming a position of absolute muscular rest, as lying down, tends to sleep. In some instances, where noise is customary, this noise is necessary to sleep.[2] The monotonous repetition of noises is rather inducive to sleep, and it is a general experience that the droning voice of a reader on a dull subject is often a most effective sleep producer. "The ripple of the ocean on the shore,

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[1] A piece of skull was removed from a dog and the condition of the brain was watched. It was noticed that when the animal went to sleep, the surface of the brain, which had previously been congested with blood, became pale. When the animal was awakened the color returned and the brain swelled up.

[2] It is notorious that the slight noise occasioned by the wheel on an ocean steamer, when stopped, wakes the sleepers. Persons living in the neighborhood of noisy mills and forges cannot sleep elsewhere. Children accustomed to the singing of the nurse require this noise to put them to sleep.

the sound of a distant waterfall, the rustling of foliage, the hum of bees," are all conducive to sleep. In like manner, successive gentle movements, like the rocking of infants, or by rubbing some part of the body, are an aid to bring sleep.

Although sleep sometimes comes suddenly, it is more generally gradual, and there are periods of slight awaking. The thoughts are given full rein and permitted to wander where they will.

Sleep may be promoted by the previous expectation of it. Thus, when the nightly hour for sleep comes, we feel sleepy. In like manner the determination to wake frequently leads to awaking at the time anticipated.[1] Habitual sounds of any kind have much less effect in arousing slumber than new sounds.[2]

Dreaming is an action of the brain-cells over which the will has no control. This mental activity may have some relation to our thoughts in the waking state, or it may not. As a rule, there is an entire want of coherence (connection) between the ideas presented in dreams. "Nothing surprises us in dreams." Occurrences that in our waking state would excite fear, hatred, or other emotions, are without effect in dreams.

In dreams the imagination works without guidance or restraint. Traces of impressions that have partially faded by time are mixed with recent events, without any reason or sense, and time is annihilated. We

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[1] A night watch in my employ trained himself to sleep and wake at the proper time to make his clock record each half hour.

[2] The doctor's wife will not be aroused by the night bell, whose first tingle wakes her sleeping husband. But the cries of her child arouse her, while her husband remains in a state of blissful unconsciousness.—*Carpenter.*

may live through a lifetime in a single night. If the dreamer acts his dreams, the condition is then somnambulism.

Unconscious cerebration is a recognized activity of the brain elements which is automatic, and of which we are not conscious. A common illustration of this, which every one has experienced, is the occasional difficulty of recollecting a name or a word. After abandoning the effort to "bring it to mind," it will occur sometime afterward spontaneously, "without thinking," suddenly flashing into our consciousness when we are thinking of something totally different.

The *amount of sleep* necessary depends more upon the quality than the length. Sound, dreamless sleep is much more invigorating than disturbed, dreamy sleep, and fewer hours will recuperate the brain. Much depends upon habit, some persons seeming to require eight or nine hours daily, while others do very well on six hours. It appears that the greatest thinkers spend the least time in sleep.[1] Hard, muscular toil promotes sleep more than hard brain work.

Insomnia, or *sleeplessness*, may be divided into two classes: Psychical (or mental) and Physical.

Psychical insomnia is the class in which sleeplessness is due to mental emotions, thought, worry, etc.[2] Physical insomnia is the class in which sleeplessness is

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[1] Frederick the Great and John Hunter required only five hour's sleep a day, while Pitt used to restrict himself to three hours.—*Hurd.*

[2] "From short, as usual, and disturbed repose, I wake.
How happy those that wake no more!
I wake emerging from a sea of dreams,
Tumultuous where my wrecked despondent thought,
From wave to wave of fancied misery,
At random drove, her helm of reason lost."—*Young.*

due to disturbance of the brain circulation, and to organic disease.

It is unnecessary to enumerate all the causes of the first class, as they are sufficiently familiar. With the removal of the cause, sleep is again resumed. Sleeplessness that comes from worry, anxiety, and emotional states frequently leads to exhaustion of the brain, to which if there be added insufficient food, we have a fertile cause of insanity.

Pain is a common cause of insomnia. Until it is removed the probability of undisturbed and sufficient sleep is slight. It is a rule that pain, and particularly that of neuralgia, is worse at night, but to this there is an exception in migraine, or sick headache. This usually yields to the desire for sleep.

If the pain can be relieved until the patient is asleep there will be a probability of the continuance of sleep. Sometimes in neuralgia a very hot application will give the temporary relief desired. Opiates should not be used, as the excitation of the brain that they cause more than overbalances the hypnotic [1] effect.

Hyperæmia [2] of the brain, usually caused by mental overwork, is perhaps the most common cause of insomnia in sane persons. The present rushing tendency of all classes of men to get ahead, leads to over-work, over-study, excitement, and mental strain. The hours for sleep are curtailed, and no time is given for relaxation and rest to the long-suffering brain cells. The constant demand for nutrition on the part of the brain

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[1] *Hypnotics* are remedies that cause sleep, and *soporifics* are medicines that produce a profound sleep.

[2] *Hyperæmia* is an abnormal accumulation of blood in vessels, short of congestion and inflammation.

to supply the worn-out material, keeps the blood-vessels full, and they do not empty themselves to get in the condition required for sleep. Sleeplessness adds to the exhaustion, and before the busy man can take time to consider and to seek relief rank mischief is done.

Hard mental work and study can be borne by the healthy person, if sufficient attention is given to the bodily need. Physical exercise is necessary, and a proper amount of the proper kind of food, and regular habits. A uniform hour should be selected for bedtime.

When the insomnia from overwork has not reached an intractable degree, a glass of ale at bedtime has a good effect.

Sleeplessness is an ordinary symptom in acute diseases and particularly in the continued fevers. Especially in typhoid and typhus fever, is this a troublesome and sometimes dangerous symptom. In these diseases baths and remedies that bring down the fevers have a soothing effect and promote sleep. The nurse can cover the head with a towel, wrung out of ice water, and wrap cold cloths about the wrist with good effect.

Indigestion, and particularly acidity of the stomach, is an occasional cause of insomnia. In these cases the evening meal should be light and the diet selected. If the *eructation* (belching) is acid, a half teaspoonful of soda bicarb. dissolved in water will correct the heartburn and allow sleep.

Sleeplessness is a usual symptom in nearly all forms of insanity. Treatment by the physician is often directed to this symptom alone. If in a hospital the nurse can aid the treatment in a great degree by making the surroundings of a patient conducive to

sleep. In a private house the difficulties may be greater, but the friends should be impressed with the importance of sleep for the patient, and insist upon quiet and a removal of all exciting and disturbing causes as far as possible.

In patients who suffer from an indefinable nervousness and inability to keep still, sometimes the slight scratching of the scalp, manicuring of the nails, holding and smoothing the wrists, rubbing the back between the shoulders, pressing firmly on the forehead, reading in a low, monotonous voice, will aid in inducing sleep. Care should be taken to exclude all flickering light from the room. The arc street light, that penetrates nearly all kinds of window coverings, is a source of annoyance.

CHAPTER XIX.

SPECIAL SENSES: SIGHT AND HEARING.

THE organs of the body that convey sensations of a special character to the brain, are known as the *sensory organs*.

The special senses are *touch*, *sight*, *hearing*, *smell*, and *taste*. These senses depend upon the brain, in which there are located centres for the several senses. The eye, for instance, conveys a particular impulse to a particular part of the brain, and the effect upon consciousness is *vision*. If the optic nerve, which connects the eye with the brain, is divided, vision is lost. It is therefore incorrect to say that we see with the eyes. We see with the brain through the medium of the eyes. If the part of the brain which is the centre of vision be diseased, vision is disordered or lost.

The same applies to all the sense organs, so that we may have disorder of the special senses from three causes: disease of the nervous centre, known as "central disease"; disease of the connecting nerve, or path, preventing impulses from reaching the brain; or disease of the sense-organ itself. The sense-organs are therefore only instruments of the mind.

Each sense-organ has its own specific irritation, and is excited by none other. Thus, the eye can be excited only by light-waves, the ear by sound-waves, etc.

If the brain portion of the special sense is irritated from any other cause than an impulse from the external organ, there are sensations that are quite similar to those produced in the natural way. Thus, from disease, the part of the brain devoted to sight may be irritated and cause a sensation of sight. Things will be seen, apparently, that do not exist, and this is what we call *hallucination* of sight. If the nerve connecting the sense-organ and the brain is pressed or injured, an impulse is carried to the brain that gives the special sensation.

The *eyeball* (Fig. 55) is nearly round. At its front part is a slightly projecting portion (*cornea*). The eyeball has three coats—an outside hard fibrous membrane (*sclerotic*), for the protection of the delicate structure within, and to this are attached the muscles that move the eyeball; the *choroid* coat, which lines the sclerotic and contains the blood-vessels; and the *retina*, a delicate transparent membrane which lines the choroid, and contains the nerve-endings that receive the impressions of light, shade, and color.

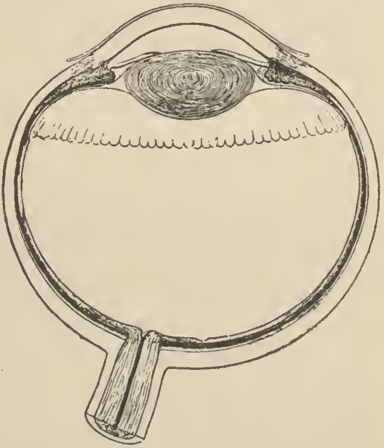

FIG. 55.—SECTION. THROUGH EYEBALL.

The front of the eyeball has a round opening, and in

this opening is suspended a lens known as the *crystalline* lens. This is a transparent, elastic body through which all the rays of light pass, and in passing through it have their direction changed so as to bring them to one point (a focus) on the retina.[1] When the light rays are brought to absolutely one point upon the retina, sight is perfect. When they do not reach a point at the retina, the sight is blurred and objects are indistinct.

Hanging in front of the lens is a curtain called the *iris*, penetrated by a round hole in the middle called the *pupil.* The pupil is subject to variation in size by the contraction of the muscular fibres contained in the iris. Its purpose is to regulate the amount of light admitted to the eye. The fibres are perpendicular to the iris, and when these contract the pupil is enlarged. Surrounding the pupil is a band of fibres, and when these contract the pupil decreases in size.

The iris has pigment, or coloring matter, deposited in its walls, and it is this substance which makes the color of the eye.

The *cornea* is a bulging, transparent, glass-like membrane that lies in front of the iris. Between this and the lens is a chamber that is filled with a fluid called the *aqueous humor.* The lens forms the front wall to a posterior chamber, which is filled with a clear, jelly-like fluid called the *vitreous humor.*

The *eyelids* are thin portions of skin that have at their margins a thin strip of cartilage. They are lined

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[1] The teacher can illustrate this by taking a lens from a spectacle and focusing the light upon a sheet of white paper.

by a mucous membrane that turns and covers the front of the eyeball, called the *conjunctiva.* This membrane is very vascular and sensitive. Every person has experienced the pain that follows an atom of dirt getting upon this membrane, and the immediate reddening of the eye that follows. The membrane is also subject to inflammation, called *conjunctivitis.*

At the border of the lids is a row of glands called the *Meibomian* glands. They secrete a thick fluid which prevents the tears from overflowing the lids.

The eyeball is constantly bathed in a watery fluid which is secreted by the *lachrymal gland.* It is spread over the globe by the movements of the lids. The excess of fluid is collected in a little sac (the *lachrymal sac*) near the nose and is carried into the nose by the *nasal duct.*

The *lachrymal gland* is about the size of a small almond, and is located at the outer and upper part of the orbit. It secretes the tears, and is affected by the emotions, and by any irritation of the eye. The secretion of tears goes on constantly, but is diminished during sleep and increased by certain emotions. When the lachrymal duct is unable to carry the tears off, they flow over the lids (weeping.)

Vision is accommodated to objects at different distances by a change in the shape of the crystalline lens. This power is called *accommodation.*[1] In young persons the lens is elastic, and can be accommodated

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[1] The teacher can illustrate the refraction of light through the lens at different distances, and show why the lens must change in shape to focus on the retina. For this purpose a section of a myopic and a hypermetropic eyeball, with lines to show the focus in front and behind the retina, would be useful, or the same purpose might be served by diagrams.

to any distance. After middle life the lens becomes harder, and will not accommodate to near objects, so that its refraction must be helped by artificial lenses (spectacles).

If the person must exercise great effort to accommodate vision, it is a strain upon the nervous system, and sometimes leads to serious nervous disease (reflex). The nurse should, therefore, watch for any indication of strain in the effort of the patient to accommodate vision, and report it to the physician[1] if observed.

There are occupations that require a use of the eyes that is an abuse of them, such as very fine work near the eyes, and particularly by artificial light. This sometimes brings on severe attacks of neuralgia and sick-headache.

Nearsightedness (myopia) is a common defect, that is sometimes inherited, but is oftener caused by abuse of the eyes or their improper care.

As a rule, in all acute diseases, the eyes are very sensitive to light, and a darkened room is necessary for the comfort of the patient.

Impressions of *sound* are conveyed to the brain by special nerves (the auditory nerves). Before the impulse travels to the brain, it must pass through a complex apparatus, called the *ear* (Fig. 56). The ear may be divided into the external, middle, and internal ear.

The *external* ear is the part that projects from the head and the *meatus*, or external opening to the *tympanum*, or ear-drum.

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[1] Frequently quite grave nervous symptoms entirely disappear by relieving the eyes from strain by artificial means—properly fitted spectacles.

The *middle* ear is a narrow cavity in the substance of the bone, placed between the tympanum and the bony wall internally. The tympanum is a very thin membrane, tightly drawn across the canal. Every sound wave that reaches this delicate membrane causes it to vibrate. Within the tympanum is a series of small bones, perfectly arranged to transmit the vibrations inwards.

There is an opening into the middle ear, connecting it with the throat, named the *Eustachian tube.* It is ordinarily closed, but the act of swallowing opens the tube and forces the air inwards.[1]

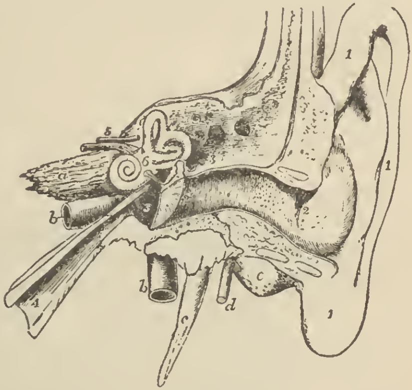

FIG. 56.—SECTIONAL VIEW OF AN EAR. 1, lobe; 2, meatus; 2′, tympanum; 6, labyrinth; *b*, carotid artery; 4, Eustachian tube.

The *internal ear*, or *labyrinth*, so named from its winding shape, is the part hollowed out in dense bone, in which the terminals of the auditory nerve are spread out. It has three canals called *semicircular* canals. If these canals are diseased or destroyed, the equilibrium of the

[1] The Eustachian tube is sometimes affected by the extension of catarrh from the throat. Hearing is almost always affected in these cases by the closure of the tube from its thickened walls or by plugs of mucus. Temporary relief is afforded by taking a swallow of water, holding the nostrils and mouth closed, and then swallowing.

body is lost, and there is a tendency to go round and round.

The mechanism of the internal ear is the most complicated in the body. The fibres of the auditory nerve are spread out over a membranous sac, which floats in a liquid that fills the cavity. Spread over this surface are fine, sandy particles. The sound waves move these particles upon the nerve terminals, producing an impulse that gives in the brain the sensation of sound.

Nature has provided well for the protection of hearing in placing the delicate apparatus within a strong bone. The external parts of the ear, particularly the tympanum, are within reach of injury, and are subject to disease and harm from lack of care.

No attempt should be made to clean out the deeper portion of the meatus, or outer passage, with ear-spoons or hair-pins. There is not only danger of injuring the delicate ear-drum, but it may give rise to inflammation.

Another source of danger is by the introduction of cold water into the ear. After bathing, the water should be allowed to run out of the ear by holding the head upon one side. No cold liquid should be allowed to run into the ear. When it is necessary to apply any liquid to the meatus it should always be warmed first.

Sometimes insects become lodged in the ear. No attempt should be made to remove them with a solid substance, and usually they can be syringed out with warm water.

In salt-water bathing, there is danger in blowing the nose after coming out of the water. The salt water may be forced through the Eustachian tube into the middle ear and give rise to inflammation.

CHAPTER XX.

SPECIAL SENSES: TASTE, SMELL, AND TACTION.

THE savor of substances introduced in the mouth

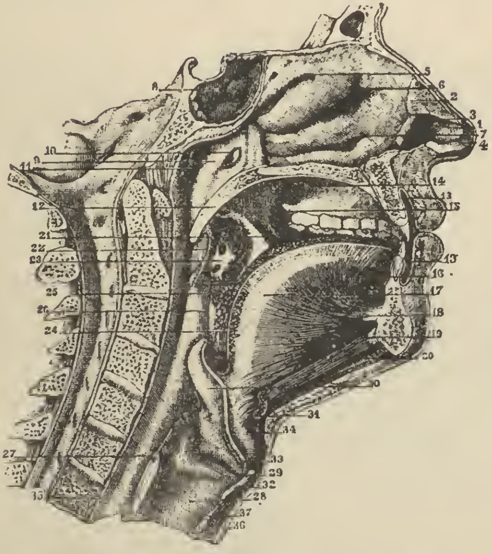

FIG. 57.—SECTION SHOWING MOUTH, PALATE, GULLET, ETC. 10, Eustachian tube; 12, soft palate; 14, arch of palate; 16, 17, tongue; 23, tonsil; 30, epiglottis.

gives a sensation called *taste*. Sweet, acid, salty, and bitter are the simple tastes, while the more delicate

flavors are unlimited. Taste, like the other special senses, can be educated. Some persons do not have nice distinctions of taste, while others recognize the most delicate changes in flavor.

The nutrition of the body has a marked influence on taste. Tempting the appetite, is the agreeable impression upon this special sense, by food having agreeable flavors.

Sometimes the taste is morbid, as in the case of chlorosis in women, who frequently crave the most unnatural articles, such as chalk, slate pencils, etc. When the taste centre in the brain is disordered by disease, the sensation of taste is produced and creates an hallucination. Insane persons frequently taste poison in their food, or have a taste sensation upon awaking, etc., the result of hallucination.

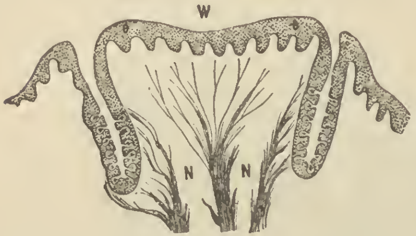

FIG. 58.—SECTION OF A TASTE PAPILLA (MAGNIFIED). W, the papilla; N, the nerves (*Landois*).

The ninth cranial nerve is the nerve of taste supplying the tongue, but it does not supply the tongue with common sensation; so that the sense of taste may be lost, and the tongue still be sensible to touch or pain.

Substances taken into the mouth have to reach the nerve terminals in the papillæ (Fig. 58) before taste is experienced, therefore substances that are not soluble, such as sand, metals, etc., have no taste. This is also the reason why taste is disordered or defective when the

tongue is much coated,—the substances cannot reach the nerves.

Different parts of the tongue and soft palate perceive different flavors. The sweet and sour tastes are best perceived upon the front of the tongue, and salts and bitters at the back of the tongue.

Taste is intimately associated with other senses, and particularly with that of smell. If the smell is disordered or paralyzed, taste is defective. The sight also has an effect upon taste, which is shown in tobacco smoking. When the smoke is not seen the taste is lessened.

The *nose* (Fig. 59) is lined throughout by a delicate mucous membrane that contains the nerve-endings of the first cranial, or olfactory, nerve, and is called the *Schneiderian* membrane.

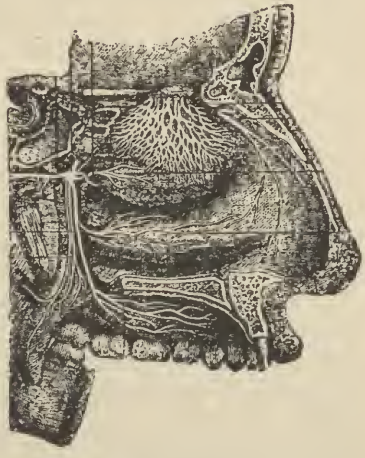

FIG. 59.—SECTION THROUGH NOSE, SHOWING NERVE SUPPLY.

The cavity of the nose is divided into two parts, viz., the anterior and the posterior *nares*. They are called the *nasal fossæ*. The essential organ of smell, or olfaction, is the mucous membrane lining the upper half of the nasal fossæ. The nasal cavity is the true beginning of the air passages. The mucous membrane is very sensitive to irri-

tation, and in an ordinary "cold" swells up so as to close the passage and prevent breathing through the nose.

The part of the mucous membrane lining the lower portion of the nasal fossæ is supplied with nerves of common sensation, and irritation of these nerves causes *sneezing*, which is a convulsion of the diaphragm and chest muscles. It is a provision of nature to expel irritating substances.

The nerves of smell are intimately connected with the sympathetic system, which is shown by the active secretion of saliva and the gastric juice caused by some odors.

Smell becomes blunted by constant exposure to single odors. Its constant use for a single odor seems to exhaust its power for that odor, but it remains acute in perceiving other odors. This is shown in the body odors peculiar to some people, which are not perceived by themselves although they may be very rank to others.

At the entrance to the nasal cavity are a number of small, stiff hairs. These are a protection, and strain the air before it enters the lungs.

In persons who are deprived of several other of the special senses, the sense of smell becomes very acute,[1] —a provision of nature to compensate for the loss.

Anything that affects the mucous membrane in the upper part of the *nares* disturbs the capacity to smell. A "cold" affecting the nose, diphtheritic membrane, etc., lessens or destroys the capacity to smell.

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[1] A deaf, dumb, and blind boy named James Mitchell, used his sense of smell like a dog, to distinguish persons and things. —*Landois.*

The sense of *touch*, or *taction*, is possessed by nearly all portions of the surface of the body. The nerve-endings are the *touch corpuscles* of *Wagner* and lie in the papillæ of the true skin. (See chapter on the Skin.) These corpuscles are more numerous on the palms of the hands and soles of the feet than elsewhere.

There are two different kinds of tactile sensations—those which relate to temperature and pressure, and those of touch proper, in the discernment of form, etc. There are also the sensory nerves which administer to painful impressions.

The sensation of touch is confined to the skin, while general sensibility giving rise to pain is general in the body. They are essentially distinct ; the one sensation may be retained, while the other (pain) may be suppressed by narcotics and diseased conditions. These different sensations doubtless have different nerve-endings, as an electrical stimulus will cause in one spot a sensation of pain, at another a sensation of heat, and sensations of cold and pressure at others. There are special "pain spots," and even "tickling spots."

The combined sensations produced by the skin and the muscles are quite complex. In the use of tools these sensations are of advantage. With a cane, we feel the ground at the end of the cane, and not the end in the hand. With a probe in a wound we can tell whether there is bone or muscle by the feeling at the end of the probe.

In certain nervous diseases the sensation of touch is disordered. The distinguishing of two sharp points near each other is one means of ascertaining the ner-

vous capacity. The instrument used for this purpose is called an *æsthesiometer.*

Common sensation is the sense of pain, hunger, thirst, fatigue, illness, and all pleasant and unpleasant sensations of the body not included in other special sensations.

Pain is the commonest of these sensations. It is caused by excessive irritation of a nerve. What may be a pleasurable sensation in one degree may become a pain in another. There are different qualities of pain, such as piercing, cutting, boring, burning, throbbing, pressing, gnawing, dull, etc. Painful impressions are abolished by substances called *anæsthetics* and *narcotics*, such as ether, chloroform, opium, etc.

In an excitable condition of the nerves, the sensibility is very much increased, so that a touch of the skin or a breath of cold air is painful. This is called *hyperæsthesia.* It occurs in inflammation of the sheaths of nerves (neuritis).

The muscles have a nerve supply that gives a special sensation called *muscular sense.* It gives an impression of the degree of contraction of the muscle. It enables us to judge of the weight and resistance of substances. The sense of fatigue is really a muscle sense.

The nurse should learn to observe any changes in the functions of the sensory organs and to properly report and record them. As an instance, the pupils of the eye in a state of health are of equal size. Sometimes in disease they become unequal, and this symptom is always one of great importance. It may occur that between the visits of the physician this symptom has been manifested, and if it is observed and properly reported by the nurse, it is frequently a service of great value.

The morbid eye conditions that serve as symptoms of disease may be enumerated as follows :

Unequal pupils.
Pinhole (or very small) pupils.
Dilated pupils.
Irregular pupils (when the border of the opening is not circular).
Diplopia, or double vision, where two distinct objects are seen instead of one.
Hemianopsia, where part of the field of vision is obscure.
Errors in refraction, either myopia, or nearsightedness ; hypermetropia, or farsightedness ; astigmatism, or in which different parts of the eye do not focus alike.
Ptosis, or drooping of the upper lids.
Twitching of the eyeball.
Photopsia, flashing of light passing before the eyes.
Muscæ volitantes, moving spots.
Hallucinations.

The symptoms given by the ear are :

Tinnitus aurium, hissing, roaring, or ringing in the ears.
Dizziness produced by gaping and coughing.
Aural vertigo (Ménière's disease).
Different degrees of deafness.[1]
Dysacousma, or pain from loud noises.
Autophony, or a peculiar sound heard by the patient while speaking with the ears covered.
Hearing the heart-beats.
Discharges from the ear.
Hallucinations.

Smell and taste do not offer as wide a variety of symptoms as the eye and ear. Tastes from eructation from the stomach frequently give indication of digestive troubles.

[1] Sometimes the nurse may discover deafness on one side by patients lying on the sound ear, that has not been previously suspected.

CHAPTER XXI.

THE ATMOSPHERE.

Atmosphere of the earth is the mass or body of gases, chiefly air, that surrounds the earth.

Air is the gaseous substance we breathe, composed chiefly of oxygen and nitrogen, but containing also carbonic acid and water. Without either of the first two air could not exist, and without the last two it is scarcely found in nature.

This composition of the air is changeable, either as it is pure or impure. Absolutely pure air contains 21 parts of *oxygen* to 79 parts of *nitrogen*. Air is transparent and invisible, odorless, tasteless, elastic, and easily moved, rarefied, and condensed.

Oxygen is the absolutely essential element for the support of animal life. Air that has removed from it only a small proportion of oxygen is not fit for breathing. It has been found that air having only 18½ parts of oxygen in 100 will not support combustion, and in such an air a candle will go out. An air with 17½ parts of oxygen will not support life many minutes.

Nitrogen composes the large bulk of the air, and its purpose seems to be only that of a diluent, or an agent to carry the oxygen. In itself it will not sustain life. During thunder-storms, ozone is formed and the nitro-

gen is changed into nitric acid, uniting impurities with ammonia of the the air to form nitrate of ammonia.

Carbonic acid,[1] although always present in air in small proportions, is also the index of impurity in larger proportions. The balance between oxygen and carbonic acid in air is maintained by the respiration of animal and vegetable life. Animals consume oxygen and give off carbonic acid, and vegetables consume carbonic acid and give off oxygen. Rain also purifies the air of carbonic acid by dissolving it. Besides, the rain drives down the air from the higher strata which contains more oxygen.[2]

Water in gaseous form (vapor) is contained in the air. It does not add to the bulk of air, and therefore does not disturb the relation of the other constituents. Moisture in air is called *humidity;* thus a very moist atmosphere is termed *humid*. As the temperature of air rises, the amount of moisture it is capable of holding increases rapidly. Cold condenses the aqueous vapor, which is easily seen by the condensation running down windows exposed to cold upon one side.

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[1] The teacher can illustrate the effect of carbonic acid on combustion very readily, by mixing in a graduate a small quantity of soda bicarbonate and any kind of acid with a little water. The carbonic acid gas, being heavier than air, will remain in the graduate. By holding a lighted match in the graduate it will be extinguished immediately.

[2] The amount of carbonic acid in air that will sustain human life has been the subject of much experimentation. The experiments of Pettenkoffer seem to be accepted, that 7 parts in 10,000 of air is the maximum of carbonic acid allowable in dwellings. The amount of oxygen in the air does not affect the bad influences of carbonic acid. Even very minute quantities of carbonic acid are sensible to the body. The difference in the air of town and country shows this. It has been shown that persons can live for a short time in an atmosphere that will put out candles.

This also explains rain. A warm air loaded with vapor is moved into a lower temperature and the moisture is condensed, falling in drops.

The air carries a vast number of impurities, some of them gaseous and others solid. Dust taken up into the air will be carried thousands of miles.[1] Vegetation in a powdered state is always found in the air in some degree. A large variety of mineral dust is constantly in the air. Micro-organisms are carried by the atmosphere, and by this means infectious diseases are frequently spread.

Ozone is oxygen changed to the allotropic state, chiefly by electricity.[2] It is produced in various ways, and is always in the atmosphere in some degree. There is more ozone in the air during the night than during the day, and most of all is found at daybreak. The fresh smell of the country air in the morning is partly owing to ozone. There is more ozone in winter than in summer, at high than at low levels, in the country than in towns, on the sea coast than in the interior, and more after a thunder-storm than at any other time.

Ozone is an exceedingly powerful oxidizing agent, and for this reason it is supposed to be a good disinfectant. It oxidizes the offensive products of animal decomposition and putrefaction, removing the odor.

Ozone has an irritating influence upon the membranes of the throat, when breathed in any concentrated form. For this reason at one time it was supposed to bear some relation to influenza. Oxygen

[1] African organisms have been found in the air in Berlin.

[2] The peculiar odor noticed when sparks are caused on the static electrical machine, is the odor of ozone.

containing $\frac{1}{240}$ of its volume of ozone, is rapidly fatal.[1]

Air is rendered *impure* by the reduction of its oxygen, an increase in the amount of carbonic acid, and by poisonous gases and floating solid matters.

Respiration uses the oxygen of the air and exhales carbonic acid. *Combustion* uses the oxygen and throws off carbon in various forms, and other gases. *Sewer-gas* contaminates the air by the gases of decomposition.

Bad air affects the nutrition of the body in the same way that insufficient or poor food does. It does not supply to the blood a necessary element in sufficient amount, and introduces material that is hurtful. The effects of foul air are usually experienced in the overcrowding of buildings without sufficient ventilation. A person can become accustomed to a poor atmosphere and not be as much affected by it as one not accustomed to it. This is shown by a person entering a very close room and feeling the need of more air, while those who have been in the room for some time do not appear to be inconvenienced. The effects of bad air on the health are shown in the history of crowded prisons, where the health of prisoners has been impaired and the mortality has been very great. The famous "black hole of Calcutta" contained 146 prisoners allowing only 20 cubic feet of air space for each. At the end of ten hours there were only 23 left alive, and these died later of a fatal fever engendered by their sufferings.

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[1] A simple test for ozone in the atmosphere is the mixture of boiled starch (200 parts) with iodide of potassium (1 part), spreading this on paper and exposing it to the air. If the air contains ozone the paper will turn blue.

The health is largely influenced by other properties of the atmosphere besides the chemical elements. The temperature, moisture, pressure, motion, and precipitation (rain), are all factors that influence health. Taken together they are known as climatic influences.[1]

The *heat* of the air is derived chiefly from the sun. This is natural heat. Artificial heat is obtained from combustibles which represent the stored up force. The difference of temperature is what causes the movement of the air (winds). The *climate* of a country largely depends upon the temperature of the atmosphere. Next in importance is the moisture, and after that, wind, rain, and pressure.

The *moisture*, or *humidity*, of the air is due to the evaporation of water from the earth's surface, and this is increased by heat and wind. Warm air is capable of containing a greater amount of moisture than cold air. Water is being constantly taken up from the earth's surface and precipitated again. It is estimated that there is at any time fifty billions of tons of water suspended in the air.

A certain amount of moisture in the air is necessary for health, as air that is too dry has a tendency to take the moisture too rapidly from the body. Air in dwellings heated by direct radiation, therefore, should have some means of supplying moisture to the air, as it becomes too dry.

The weight of the air is dependent upon its height and its temperature. The higher up one gets, the lighter and more rarefied the air is.

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[1] The climatic treatment of disease has become an important department of medical science. Certain diseases are influenced more by conditions of the atmosphere than by any other means.

Variability of climate is the most unhealthy element. A dry atmosphere is a healthy one. Especially for diseases of the respiratory organs, a dry air is desirable. For this reason the desert air and the higher plateaus of Colorado, and mountain climates generally, are recommended for pulmonary diseases, but to be of service the occupation must be out-of-doors.

The best climate is that in which a delicate person can be out-of-doors with comfort and safety the greater part of the year.

Climate of high altitudes is healthy on account of the dryness, the clear sky, low atmospheric pressure, and the evenness of the temperature.

CHAPTER XXII.

VENTILATION.

Air is necessary to sustain life,[1] and pure air is necessary to preserve health, and to recover it in illness.

Air is rendered *impure* by gases that are mixed with it, and by the oxygen that is consumed out of it.

The impurities come chiefly from the exhalations from the lungs and skin. Combustion of fuel reduces the oxygen in the air, and creates carbon dioxide. Few persons have a proper conception of the amount of impurity caused by burning gas.

The relative amount of impurity from petroleum lights is greater than from gas, and from candles still greater than from petroleum. The impurities from fires are carried out of the chimney by the draught. There is an exception to this in the modern base-burning stove in which the draught is frequently shut off, allowing the escape of the poisonous carbon monoxide and sulphur compounds through the cracks of the stove into the room. This produces symptoms of chronic poisoning—headache, dizziness, languor, loss of appetite, nausea, etc.—and accounts for many cases of sickness not otherwise accounted for.

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[1] See chapter on "Respiration."

If a man were sealed in a perfectly air-tight room, he would die of suffocation before starvation would cause death. Perfect exclusion of air is difficult to secure, for it penetrates almost every solid substance, especially of building materials.[1]

The quantity of air coming through the walls is not sufficient, however, and if there were no other means of getting air, life could not be sustained.

Taking an ordinary room used for household purposes, we have the exhalations from the lungs and bodies, the impurities given off by lights,[2] the gases probably leaking from stoves, the floating dust from floors and furniture, to render the air impure.

These are the difficulties encountered in health, but in hospitals and houses where disease is present, we have additional causes of contamination, and in the sick person, a lessened power of resistance against its deleterious influence.

It is, then, self-evident that one of the greatest requirements for health is the constant renewal of the air in living-rooms; the removal of impure air to be replaced by pure air.

After many careful experiments, scientists have concluded that to maintain the air at a wholesome standard, 3000 cubic feet per hour for an individual are required. Assuming that the air is changed three times an hour, a space of 1000 cubic feet would be re-

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[1] A candle may be blown out through a brick. Take a blow pipe and place the end against a brick and the candle upon the other side. Constant blowing will establish an air current through the brick, that will extinguish the candle.

[2] It is said that a single burner of gas consumes more oxygen than would be needed for three persons.

quired for an individual. This is the standard usually adopted in hospitals.[1]

In many private houses of the middle class, there is usually a greater individual space, but no arrangements, as a rule, for ventilation, except through doors and windows. In tenements the space is sometimes shamefully small, and the wonder is that the mortality can be kept so low under such untoward conditions.

A sick person needs at least twice as much air as a person in health. The respiration is usually very much hastened in sickness, and the body exhalations, like tissue consumption, are much increased.

The removal of impure air and the entrance of pure air in its place is called *ventilation*. When the air comes through the natural openings in a house, the doors, windows, cracks, etc., it is called *natural ventilation*. When the air is changed by some means or apparatus constructed for the purpose, it is called *artificial ventilation*.

Air, when heated, expands and becomes lighter in weight. If the air within and without a chimney were at the same temperature, it would be at perfect rest; but place a lighted candle at the bottom of the chimney and heat the column of air, and it will rise and cause cold air to rush in at the bottom.[2]

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[1] In the St. Lawrence State Hospital, single sleeping-rooms have an average of 1200 cubic feet, and associate dormitories a space of 700 cubic feet per individual, with an estimated change of air each fifteen minutes.

[2] This is substantially the mechanism of winds. A stratum of air in one part of the country becomes warmer from some cause than the surrounding atmosphere, and it rises, for the same reason that a cork rises in water, the air from the surrounding strata and sections of surface rush in to fill the space (vacuum), and this movement of air is called wind.

If two closed rooms were divided by a brick wall, and one contained pure air and the other carbon dioxide, or other foreign gas, it would take but a short time before the air in both rooms was equal in composition. This property is called the *diffusion of gases.*

These two natural processes—movement of expanded air and the diffusion of gases—are the two natural means of purifying and changing the air in houses.

Natural ventilation is dependent chiefly upon the movement of air produced by warming, upon the action of winds, and by diffusion.

When the temperature of the air in a house is higher than that outside of the house, the warm air seeks an exit and cold air an entrance. Doors and windows furnish the largest supply of fresh air. Every time the door is opened there is a rush of air. A fireplace and chimney, even without a fire, allows an easy exit for foul air. With a fire it becomes artificial ventilation. Stoves usually have their dampers shut down to such a degree as to carry off but a small quantity of air.

Where natural ventilation is depended upon, there should always be openings enough to allow a current of air to be moving through the room, even in cold weather. The air admitted should be pure, and not be taken from other rooms where it may have been already used. The best natural ventilation next to a fireplace, is by windows on opposite sides of a room. When these are open, a current of air is always produced. A nurse having the selection of a sick-room should bear this in mind.

The precaution should be taken that air currents circulate about the whole room. Two opposite windows open from the bottom may have a current driven

from one to the other window without giving adequate ventilation. It is a good plan to have one window open from the bottom and the other from the top. Where there is only one window in a room, if the top and bottom are equally open, a circulation of air will be produced, the warm air going out above and the cold air entering from below.

As air is warmed it always rises, therefore the top of the room is a number of degrees warmer than the floor line. The temperature at the head is much warmer than at the feet, when a person is standing. This is particularly true of a room in which the air is not in circulation. When the air is properly circulated, the temperature is more equalized. This shows the advantage of removing the air from near the floor line.

The change of air should not be rapid enough to cause a *draught*. When windows are open they can have boards or books arranged as screens, so as to throw the current in an opposite direction from the bed. Sleeping-rooms with open windows must be particularly seen to in this respect. The body in a state of sleep is much more likely to be affected by draughts, on account of its lowered vitality at that time.

A good and simple arrangement in rooms having but one window, is to raise the lower sash a short distance and place a board across the opening below, when the air will enter between the sashes and cause an upward current (Fig. 60). Another good plan is to thoroughly ventilate the adjoining room and draw the air from that to the sick-room. In this way the fresh air can be properly warmed even in the coldest weather. The nurse must always remember that it is as necessary to have an exit for foul air as to have a supply for fresh

air. There is no better exit than a fireplace chimney; and even without a fire, by placing a lamp in the opening an upward current can be started.

Ventilation in the summer time is a comparatively simple matter, as the fresh air does not have to be warmed. In the winter, however, it becomes one of the most difficult problems the nurse has to meet, particularly to ventilate the sick-room properly in houses that have no special provision for ventilation. But ventilation is an absolute necessity, and it is the nurse's duty to see that the patient is provided with a sufficient amount of pure air at a proper temperature. It is in the discharge of this function that the efficiency of a nurse is shown. In nearly all hospitals, ventilation by artificial means is provided for.

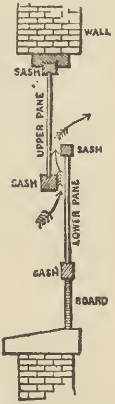

FIG 60.—SECTIONAL VIEW OF WINDOW WITH LOWER SASH RAISED —*Buck.*

The nurse should ascertain that the source of the air entering the room is pure. See that no contaminating influences affect the admitted air—cesspools, decaying vegetable matter, etc.

In malarial districts, the emanations from the soil are particularly active at night. It is, therefore, better to have the sick-room in the second story in such a locality.

A thermometer should hang in the room at the height of the bed, so that the nurse can ascertain and regulate the temperature of the air breathed by the patient. In fevers the temperature may be from 60 to 65 degrees F., and in lung diseases 70 degrees F.

The vitality of the patient is lowered between mid-

night and morning, and the temperature of the room may be increased during those hours. Hot drinks, an extra blanket, hot-water bags to the extremities, etc., may be necessary.

Where it is practicable to move the patient into an adjoining room the sick-room can be thoroughly aired by throwing up the window, but care should be taken that the temperature is right before returning the patient. The nurse must not be satisfied with this periodical ventilation, for fouling the air goes on constantly, and must be constantly renewed. Like periodical house-cleaning, this thorough airing of rooms helps to remove any sick odor, and is a satisfaction to the nurse and patient.

CHAPTER XXIII.

WARMING AND VENTILATION (CONTINUED).

Artificial Ventilation may be effected by heat currents, or by force. Dependence upon the tendency of heat to rise, is the usual medium for artificial ventilation.

Forced ventilation is either by driving the air into a room with fans, allowing it to find its exit through flues, or by sucking the air out of a room by fans or pumps, the suction attracting the air into the room to fill the vacuum. The several systems appear to be of equal efficiency.

The favorite system of ventilation at the present day, is the combined system of warming and ventilation; the heat accomplishing the two important functions—that of supplying a proper temperature and fresh air.

A *furnace* is a large heating surface, usually located in the basement, provided with chambers in which the fresh cold air is admitted. It is warmed in these chambers, and when heated rises through flues (tubes) through which it is directed to different rooms. In this way fresh air is driven into the room heated to a proper temperature. The pressure created by the entrance of the heated air forces the impure air out. This is a system of indirect heating, and is chiefly used in private houses. The entrance into the room is con-

trolled by dampers or valves, so that the heat and supply can be partially or wholly shut off (Fig. 61).

One objection to furnace heat is the removal of all moisture from the air. This can be corrected by having a supply of water in the heating chambers, or open dishes of water in the several rooms. Another objection is that when the heat is not required the flues are closed and the supply of air is shut off. Some systems are arranged with a separate cold-air supply.

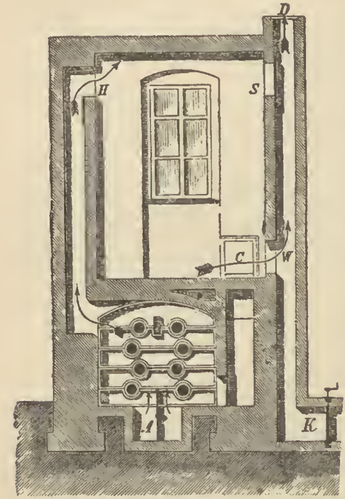

FIG. 61.—DIAGRAM SHOWING VENTILATION BY FURNACE OR AIR HEATED IN THE BASEMENT. A, cold air enters on heater; H, warm air enters the room; W, fouled air escapes into ventilating flue.—*Buck.*

Indirect radiation is a combined system of warming and ventilation either by steam or hot water. Steam is usually the medium in large buildings, and hot water in private houses.

The *steam* is carried through coils of pipes, or radiators, in the basement. These coils are enclosed in chambers which are connected with the outside by flues, admitting the fresh cold air. The air is heated by passing over the coils, which causes it to rise through flues into the several rooms. Thus fresh air is forced into the room, and by heating the air to a proper degree two purposes are effected. There is a correspond-

ing system of flues to allow the impure air to escape from the room. These (ventilating) flues are gathered into trunks in the attic and pass out through stacks into the open air. The first system of flues is known as heating flues, and the second as ventilating flues.

The heating flues open into the room near the ceiling, the ventilating flues near the floor (Fig. 61). The purpose of this is evident from the fact that heated air will always rise. If the ventilating flues opened near the ceiling, the heated air would enter the room and immediately pass out through the ventilating flues. The latter opening at the floor line act by constantly pulling the air downwards, and this force or attraction keeps it in circulation until it reaches the bottom of the room.

Indirect hot-water systems are precisely the same as steam except that the circulating medium is hot water. This has the advantage, in spring and autumn, of allowing a slight change in temperature by merely warming the water, whereas water must reach 212 degrees of heat before it forms steam for circulating.

The objection to either system is the same as that applied to furnace heating, viz., that when the heat is not wanted, the air supply is shut off with the heat. This can be remedied by having a separate cold-air supply.

The hospital nurse should become thoroughly familiar with the system of ventilation in vogue in her particular institution, in order that she may know how to control both heating and ventilation of the wards intelligently.[1]

Direct radiation is the system of heating by passing

[1] The teacher should explain in detail the system in use in that particular hospital.

steam or hot water through coils or radiators in the room to be heated. This provides only for heating, and the objection to it is the usual failure to provide any method of ventilation. A system called the *direct-indirect*, has openings from the outer air leading underneath the radiators, thus heating the air before it circulates in the room. This is an admirable plan, as when the heat-supply to the radiator is turned off, it allows the entrance of fresh air.

There is also a system by which large quantities of air are heated at some central point, and the warmed air is distributed by flues to the several rooms forcibly, by large revolving fans.

When air is drawn out of a room or building by artificial means, the method of *extraction* is said to be employed. When fresh air is forced in, the method is termed *propulsion*. An open fire, which attracts the air up the chimney, is ventilation by extraction.

Nurses must exercise vigilance to see that ventilating flues are kept open. Many patients have an idea that they are hurtful, or that they make a draught, or for some other reason cover them over. This must not be allowed, for upon the proper action of a ventilating flue depends the wholesomeness of the ward.

Sometimes air currents do not work properly, and instead of the current of air ascending the flue, the current is downward. In this case there is something wrong that needs attention, and it should be reported.

A good way to test the movement of air, is to drop a handkerchief over the face of the flue, and see if it sucks it up. Taking the size of the flue and the room into consideration, a fair estimate can be made of the rapidity with which the air is changed in the room.

It is good evidence that ventilation is perfect, when there is an absence of institutional odor. Poor ventilation can be detected by one coming from the outer air, by a smell of closeness. Such a smell in a ward denotes a lack of care, or defective apparatus. If construction provides for ample ventilation, then the nurse is to blame for not using the means at her command.

Sometimes ventilating flues that will not draw, can be corrected by a gas-jet kept lighted in them, or by a small coil of steam pipe placed in the flue.

There is no better means of ventilation than a fire in an open grate. It may not be sufficient to heat the room, but this can be supplemented by other means. The open fire is not only an admirable ventilator, but there is nothing more cheering in the sick-room.

After evacuations of the bowels, or dressing of putrid sores, the room should be quickly and thoroughly ventilated. The patient can be thoroughly covered, but the danger of draughts to persons in bed is not very great. Florence Nightingale stated that "patients in bed do not catch cold." To free the room from smell, to assist ventilation, pour vinegar or cologne upon a heated shovel, or use a spray of cologne. Do not burn pastilles, brown paper, or anything that makes a smudge.

When stoves *have* to be used in heating sick-rooms, great care should be taken not to let them get red-hot. In this condition, carbon monoxide escapes through the red metal into the room, and this is rank poison.

If the stove is near a window, by an arrangement of screens the cold air can be conducted to the stove and warmed. The ingenious nurse will suggest many ways to overcome apparent difficulties, recollecting

that the foul air must be removed, and sufficient pure air must be introduced.

It is important to cool the sick-room in very hot weather. Where rooms are exposed to the sun, Venetian blinds should be fixed. The room may be cooled by placing large blocks of ice in dish-pans. Atomizing water and cologne in the room helps to cool it. Hanging up wet sheets to increase evaporation, or branches of trees that are kept wet and hung up in the room cools the air. Evaporation abstracts heat and is cooling.

CHAPTER XXIV.

MICRO-ORGANISMS (BACTERIA, FUNGI, ETC.).

THE great world of organic life, of which the members singly are not apparent to the human eye, known as *micro-organisms*, assist to sustain and destroy the human race.

There is a great variety of micro-organisms, but the class which is most concerned in disease are *bacteria*.

Micro-organisms are present everywhere in our food and water, in the air and the upper layers of the ground. Some of them are disease-germs causing the infectious diseases; others cause fermentation, and others cause putrefaction.

Disease-germs are of three varieties, named according to their form, viz., *micrococci*, *bacilli*, *spirillæ* (Fig 62). The first-named are round or slightly oval, while bacilli are rod-shaped. *Bacteria* is the name given to disease-germs in general. Under certain conditions, bacteria change themselves into *spores*. It is in this state that they are distributed and increase when placed in a proper medium. It is a state of suspended activity resembling the hibernation of animals, and they may remain inactive for months, or even years, until they are placed in a favorable condition for growth.

Bacteria multiply with great rapidity. Starting from a point placed in beef-tea, or a suitable medium,

which cannot be seen with the naked eye, in two or three days' time they increase to such an extent as to discolor the medium.

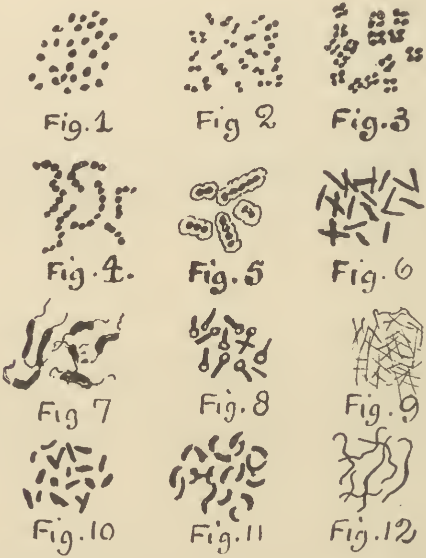

FIG. 62.—SHOWING THE MORE COMMON FORMS OF BACTERIA. (1) Micrococci of pus; (2) diplococci (arranged in pairs); (3) sarcinæ; (4) streptococci (grouped in chains), the germs of erysipelas; (5) diplococci in capsule, common in pneumonia; (6) bacilli of typhoid-fever; (7) bacilli with cilia; (8) bacilli with spores, produces tetanus; (9) tubercle bacilli, producing consumption; (10) bacilli of diphtheria; (11) spirillæ of cholera; (12) spirillæ of malaria.

Water is necessary for the growth of bacteria. In the dry state they exist as spores, and are distributed

in dust, but until they reach moisture they will not multiply.

Warmth is also necessary for their growth. The heat of the body is favorable, but the most favorable temperature is between 86 degrees and 95 degrees F. Growth of bacteria is retarded below 65 degrees F. Nearly all germs are killed in a few minutes by a temperature above 160 degrees F.

There are a great many species of bacteria, and every form of infectious disease has a germ peculiar to it.

Pus is caused by micrococci. Suppuration in a wound whereby pus is secreted, will not exist if the wound is protected against the entrance of germs.

The *anthrax bacillus* is a most deadly variety of bacteria. It attacks whole herds of cattle and sheep. The minutest trace of this poison inoculated into the body will cause death. Natural infection takes place by the introduction of spores in the food, and the disease consequently begins in the intestines.

Before the days of antiseptic surgery, wounds were frequently fatal through being poisoned by a germ present in decaying matter, dust from old dwellings, rags, hay, etc., that caused gangrene. It is now a rare condition.

Typhoid-fever bacillus is introduced through the mouth and causes disease of the intestines.

Pneumonia has a germ that is found in the sputum coughed from the lungs.

Tuberculosis, or consumption, chiefly of the lungs, is caused by a bacillus that infects by being breathed or swallowed, or by inoculation. The disease is never brought about in any other way. It is probably distributed by the spores being spread in dust oftener

than in any other way. The greatest care should be taken that the sputum of consumptive patients, in which the bacteria exist, be destroyed, or disinfected. This disease is common to cattle, and no animals seem to have an absolute immunity from it.

Glanders, an infectious disease common to cattle and horses, has a characteristic bacillus, which also poisons the human body. It infects by inoculation.

The terrible disease *diphtheria* is caused by a germ. It is very infectious, and the greatest care must be exercised by the nurse in attendance upon diphtheria patients, in order not to become infected.

Tetanus, or *lock-jaw*, is caused by a characteristic bacillus. The spores are in garden earth and this accounts for lock-jaw occurring after wounds caused by dirty nails, splinters, etc.

The *comma-bacillus* (so named from its shape) is the cause of Asiatic cholera. This is a disease of the bowels, and it is there the bacteria are found. It is an exceedingly infectious disease, but fortunately the juices from the healthy stomach have the property of destroying this germ.

Infection of the body by bacteria is the only manner in which infectious diseases can be caused. But the human body has the property of destroying the poisonous germs to a great extent. If this were not so, it would require only a short time to depopulate the earth. There must be a predisposition ; in other words, the blood and tissues must be in a state to propagate the germs, before the disease is taken. As a rule, bacteria are killed by the healthy stomach. It follows that indigestion and stomach disorder is a predisposing cause of infection.

In *tuberculosis*, heredity, which was formerly believed to be the cause of it, is now known to be only a predisposing factor. Experience has shown that lowering of the tone or vitality of the body, whether by unhealthy living or by disease, predisposes to infection.

In many of the infectious diseases, immunity is given by once having the disease. The theory of preventive inoculation rests upon this fact.

In the case of small-pox, inoculation by vaccinia virus gives immunity against it.

In some other diseases, such as hydrophobia, tetanus, and diphtheria, the poison is attenuated (weakened) by frequent dilutions or cultures, and the inoculation of the weaker virus protects against, and even cures, the diseases in the first stage (antitoxins).

Milk in the raw state and food that is cold, or that is eaten after standing for some time, affords an easy way of carrying infection into the body. Besides, these articles furnish the material upon which bacteria can live and multiply. Drinking-water is a good medium for carrying the infection, but bacteria do not multiply in it. The poison of typhoid fever is nearly always introduced in the drink.

Infection from want of cleanliness—from coming in contact with micro-organisms—is a fertile source of disease.

Bacteria are discharged from the body in several ways. Many bacteria are destroyed within the body, and they are thrown off only from those organs which suffer the characteristic lesions. Thus the intestines in typhoid fever and cholera, the skin in small-pox and scarlet fever, etc., are the only sources of the infection.

It is interesting to know how the blood protects itself from these invading organisms. The white blood corpuscles (leucocytes) are the valiant soldiers for defence. When the bacteria enter the blood, the leucocytes attack them, eat them up, and digest them. At the point of inoculation the leucocytes gather and attack the micro-organisms, and doubtless sometimes totally destroy them. This process is called *phagycytosis.*

CHAPTER XXV.

DISINFECTANTS.

DISINFECTION is the destroying of the bacteria considered in the last chapter. It is also the neutralizing of miasms, virus, and the gases of decomposition and putrefaction.

Disinfectants are the substances used for disinfection. Decomposing matter is usually characterized by foul odors, and disinfection usually destroys the odor; but the bad odor is not injurious in itself. There are substances that neutralize the odors without destroying the germ or injurious principle. Substances that neutralize bad odors are called *deodorizers*.

It does not follow that all infectious matter has an unpleasant odor; the products of decomposition and putrefaction usually do have, and disinfection and deodorizing are processes that go together.[1]

Antiseptics are substances that have the power of arresting putrefaction or decomposition of organic material. Some substances are both antiseptic and disinfectant. Disinfectants are all antiseptics.

Germicides are those disinfectants that have the prop-

[1] The definition of a disinfectant given to the public by the American Public Health Association is an excellent one, viz.: "A disinfectant is an agent capable of destroying the infective power of infectious material."

erty of destroying infectious material that is composed of micro-organisms, or bacteria. But it is hardly worth while to make this distinction, and the term disinfectant answers every purpose.

The knowledge of bacteria and the substances that destroy them is in a constantly progressive stage. The list of disinfectants is constantly enlarging and changing, so that what may be given at this time as the most potent disinfectant, may be replaced by another in a few months.

Heat is probably the most certain destructive agent of germ life. Boiling for half an hour will destroy the vitality of all known disease-germs, and there is no better way of disinfecting washable clothing than by boiling it.

Moist heat and *dry heat* are used for disinfecting purposes. A lower temperature is required to kill germs, when the heat is moist (hot water). Thus it was found by Koch that a dry temperature of 212° F. maintained for one hour, was required to kill bacteria without spores, and spores required for their complete destruction a dry temperature of 284° F. maintained for three hours.

In moist heat, a temperature of 140° F. for ten minutes destroys a large proportion of pathogenic (disease) germs. A jet of steam for fifteen minutes at a temperature of 200° F. will kill the tubercle bacilli in fresh sputum.

Disinfecting ovens are now made of sufficient size to put in a whole bed, which is then subjected to a steam pressure of fifty pounds for half an hour. This apparatus is seldom available, and other and simpler means must be substituted.

There are many chemicals that are used as disinfectants, the chief of which is *carbolic acid.* It is one of the coal-tar products, is in the form of white crystals, and is easily soluble in water to the extent of 1 part in 20. It requires a solution of this strength to be effective as a disinfectant, although weaker solutions may act as antiseptics. Watery solutions of carbolic acid are much more effective than solutions in oil and alcohol.[1]

As the broken skin absorbs carbolic acid, it must be used of weaker strength on wounds or broken surfaces. Solutions comparatively weak applied to the skin cause whitening and shrivelling, and numbness and prickling, afterwards followed by smarting.

Corrosive sublimate, or bichloride of mercury, is about equal to carbolic acid as a disinfectant, or even superior. A solution of 1 to 1000 parts destroys all spores in a few minutes, and even solutions of the strength of 1 to 10,000, with one hour's exposure will destroy many varieties of bacteria.

The strength of solutions usually employed is from 1 to 1000, to 1 to 3000. As it is an extremely poisonous chemical, weaker solutions must be used where there are broken surfaces, or in cavities,—1 to 5000 and 1 to 10,000.[2] As there are less poisonous disinfectants that do equally well, bichloride should not be used where

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[1] If the nurse is called upon to make a solution of carbolic acid from the crystals, they should first be liquefied by placing the bottle in hot water. Then divide the contents of the bottle for the solution by 20, and measure out this quantity of the liquefied acid, and pour in the bottle, afterwards filling the bottle with hot water and shaking vigorously. This will make a saturated solution. If it is not all dissolved, drops of the acid, like oil, will float in the solution. This should be watched, as one of these drops applied to the skin would act like a caustic.

[2] Corrosive sublimate is put up in tablets, so that it is easy to gauge a solution.

there is danger of absorption. It also stains white clothing, and corrodes metal instruments. The solution requires to be made often as it decomposes and loses it power by standing, although an equal amount of sodium chloride (common salt) added to it will prevent decomposition.

Sulphurous acid, or the fumes from burning sulphur, is popularly believed to be an active disinfectant. It is a reputation it does not deserve, for it has been definitely settled that it does not affect spores, even when exposed for 24 hours. In the presence of moisture, however, this agent will destroy bacteria without spores readily.

The favorite method of fumigating rooms with burning sulphur would seem, therefore, to be unreliable, although in cases of disease where the excreta have been properly treated it might be sufficient.

Chloride of zinc in solution of 2 to 100 is effective in destroying a large variety of bacteria, but spores resist its action. The solution should be made fresh whenever used.[1]

Boric acid is a disinfectant with feeble powers. In a saturated solution[2] it will destroy bacteria after a long exposure, but will not affect spores. The advantage of boric acid is its harmlessness. It can be used about the mouth or in cavities without irritation.

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[1] A method of making this solution is to take 4 ounces of sulphate of zinc (white vitrol), 2 ounces of salt, and one gallon of water. The chemicals can be kept in packages weighed out, ready for use. This is also a good deodorizer for water-closets.

[2] A "saturated solution" is the full capacity of the liquid to dissolve. If there are some remaining crystals after the mixture is thoroughly shaken, it is an indication of a *saturated solution*.

The *chlorides*, particularly *chloride of lime*, or the *hypochlorites* in *Labarraque's solution* are germicides of the lower order. Their great advantages are their cheapness and their deodorizing qualities. The *lime chloride* used in powder in privy vaults and in large decomposing masses is the best substance we have. *Labarraque's solution* can be used slightly diluted in large ulcerating sores, but presents no advantages over carbolic acid.

Permanganate of potash is an effective germicide in a 5 per cent. solution, but it can be used with safety in saturated solutions. It is used in applications to mucous membranes and in bathing the hands before an operation.

Chlorine gas, if used in the presence of moisture, is a most active disinfectant. In fumigating a room, however, it would be necessary to saturate the room with steam at the same time, and this process is so complicated as to almost exclude it from possible use.

Sulphate of copper in one per cent. solution will destroy micrococci, but not bacilli. It is a useful disinfectant in 5 per cent. solutions for bodily excreta in infectious diseases.

There are a vast number of chemicals that have greater or less distinfectant properties, but there is no advantage in reviewing them. Those already given are in common use, and the nurse should become intimately acquainted with their properties, appearance, and uses.

Upon disinfection depends in a great measure the control of epidemic infectious diseases. Latterly, the recognition of tuberculosis as a disease that can be communicated by its specific germ, has led to the disinfection of the sputum, and there is no doubt that a

careful observance of this precaution would reduce this widespread and fatal disease.

One of the most requisite duties of a nurse is the careful observance of rules of disinfection. The proper care of sputum in pneumonia and tuberculosis, of the discharges in typhoid fever, of the skin and clothing in scarlet fever, etc., will be an indication of efficiency.

CHAPTER XXVI.

DISINFECTION (CONTINUED).

EVERY means taken to prevent infection, or contamination, by micro-organisms is termed *antisepsis*.

The most efficient antisepsis is thorough *cleanliness*. Where there is absolute cleanliness there can be but a small opportunity for lurking infection. Cleanliness includes immediate disposal and destruction of all bodily excreta, and the sterilization and disposal of all soiled clothing, bedding, etc.

Sterilization (Fig. 63) is synonymous with disinfection, but its use has latterly been confined to the use of heat in the destruction of disease germs. Thus cooked food is sterilized. Clothing that is put through the ordinary laundry process is sterilized.

It is therefore important that all clothing and bedding that are used around persons suffering from infectious diseases and suppurating wounds, etc., should be changed frequently, and should not be permitted to lie around. Such fabrics should be sent to the laundry at once, or at least be removed from the house, or be wrapped in a sheet that has been sterilized with a solution of bichloride or carbolic acid.

During the care of a case of infectious disease, the utmost antiseptic precautions should be taken. Isola-

tion of the patient in a room prepared with as few articles of furniture as possible, is desirable. It is much better to have a wood floor with rugs or strips of carpet than a carpeted floor, as these loose articles can be thoroughly dusted and the floor kept clean.

FIG. 63.—STERILIZER.

In all cases of infectious disease free ventilation is of the greatest importance, and in itself is a valuable antiseptic. The best way of disinfecting the air is to exchange it for pure air. Oxygen is a disinfectant.

The nurse must take antiseptic precaution for her own sake, and to prevent the spread of disease by communicating with others. She should take daily open-air exercise, and always change her clothing before going out. It is a good plan to avoid outsiders. The hair can be prevented from carrying infection by wearing a close cap. All clothing worn should be washable.

In preparing a room for an infectious case, a large proportion of the furniture can be removed, as a rule. All wall hangings, curtains, portières, etc., should be taken down. The nurse should bear in mind that sub-

sequent fumigation may destroy the color or even the fabric of upholstered furniture and hangings.

The best way to sweep is to cover the broom with a cloth wet in carbolic acid, or bichloride solution. There should be no dusting, but the furniture and woodwork can be wiped with a cloth dampened in a disinfectant solution.

If the disease be very contagious a proper precaution is to hang sheets in front of door and window openings, wet with a disinfectant.

All cloths used in cleaning should be allowed to lie in a 5 per cent. carbolic solution.

Disinfectant solutions should be kept in bottles plainly marked, so that no mistake can occur in their use. A nurse should always see that an ample supply is provided.

In diseases where the evacuations are infectious, such as dysentery and typhoid fever, the chamber-vessel or commode-pail should be a closely covered one, and should, as soon at it is emptied and cleaned, have the disinfectant to be used placed in it ready for use again.

The best disinfectant for this purpose is a 1 to 2000 solution of bichloride,[1] but chloride of lime in powder, carbolic acid, or even a strong solution of sulphate of iron will suffice. The stool should be allowed to stand exposed to the disinfectant before being disposed of. Always cover the vessel before carrying it away.

Where it is practicable, exposing the excreta to a jet of steam, or pouring boiling water upon it, is as effectual as the best chemical disinfectant. The stools may also be mixed with bran or sawdust and burned.

[1] Bichloride of mercury is corrosive sublimate.

The parts should always be wiped off with a rag dampened in carbolic solution or a saturated boric acid solution, preferably to being wiped. Any soiling of the bedding should lead to its immediate changing.

The sputum of patients suffering from infectious lung diseases, or diseases of the mouth, nose, and throat, should be disposed of with the same care. A special cup (Fig. 64) should be provided for these cases, made of some non-absorbent material, preferably glass or china, and should contain a strong bichloride solution, or the sputum can be covered with boiling water. A good plan is to make a cup of hardware paper, which can be frequently burned.

FIG. 64.—GLASS SPIT-CUP.

All cups or instruments that are used should be kept immersed in a 1 to 30 carbolic solution, and boiled before being used by another patient.

Bed-pans and any other material should have precisely the same careful treatment. If the nurse constantly bears in mind that infectious material becoming dry is easily carried as dust, it will aid her to appreciate the proper care of it.

A set of dishes should always be kept for the exclusive use of the patient and be washed by the nurse, first allowing them to lie in boiling water for a time. It is well to use for wiping the mouth cloths that can be burned. As a rule, all things practicable in use about an infectious case should be destroyed by fire, after its use. The next best thing is to expose it to steam, and the next best to boiling water.

The nurse should take all these precautions in a quiet way and not emphasize the danger of infection to friends who can be frightened into an illness, unless they are opposed to necessary proceedings.

The burning of pastilles, aromatics, etc., serves no purpose whatever, except to foul the air. Exposing disinfectants in an open vessel is of little value, although the hypochlorites correct foul odors. No vaporous disinfectant in quantities that will permit living in the room, is of any avail.

With a body that has died from infectious disease the greatest care should be exercised. The nose, mouth, and all passages should be plugged with cotton soaked in a strong disinfectant, the body should be washed with it and wrapped in a sheet soaked in it. The burial should not be delayed, and the body should be placed in a hermetically sealed box, and not exposed to the open air at the funeral.[1]

A room that is vacated after being occupied by a patient with an infectious disease must be thoroughly disinfected. As far as possible, heat should be used in boiling all clothing and bedding, and by oven-heating the furniture where this is possible. The walls, floor, and ceiling should be scrubbed and then thoroughly painted with a 1 to 1000 solution of bichloride. Rubber articles—sheets, syringes, etc.,—can be soaked in Condy's fluid,[2] or Labarraque's solution. Where steam can be introduced into the room, fumigation by sul-

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[1] The common-sense method of body disposal, especially when death be caused by infectious disease, is by cremation. It is to be hoped that the time will come when sentiment will not prevent this sanitary precaution.

[2] A solution of permanganate of potash.

phur or, better still, chlorine gas can be tried, but the value of this method is uncertain. Fumigation should not be depended upon alone, but it may be used in conjunction with other methods.

The process of fumigating with sulphur is to fill a large dish-pan half full of water. Place some bricks in the centre of the pan, upon which the sulphur is placed in a metal dish and set on fire. Every thousand cubic feet of space requires two and one-half pounds of sulphur. All cracks in the room admitting air should be plugged with paper or cotton. Leave the room, shut the door tightly, and keep it closed for 24 hours. Then open the doors and windows and allow the room to air thoroughly. Sulphur will turn all metals black and will bleach colors.

Chlorine gas is made by mixing equal parts of sodium chloride and black oxide of manganese in an earthen dish and adding sulphuric acid diluted with an equal amount of water. Chlorine gas is heavy and there must be an amount sufficient to fill the room, or the ceiling will not be reached.

As a rule, the best thing to do with clothing and bedding that remain after the death of the patient is to burn them. It is better to bear a small loss than to run any risk in spreading the disease.

CHAPTER XXVII.

THE SICK-ROOM: ITS PREPARATION.

EVERY nurse should be capable of entering a house and giving full and minute directions for the preparation of the room in which the sick person is to be cared for. Much depends upon the character of the illness—whether the case be medical, surgical, or obstetrical.

The efficiency of the nurse is indicated by her adaptation to circumstances, and by using the things she has at hand to serve her purpose. The arbitrary nurse that makes demands for materials and conditions that are difficult or a hardship to procure, places herself at once on the wrong side of the family. To gain the sympathy and friendship, not only of the patient but of other members of the household, should be a point in view. Get your requisites without a demand. Be flexible in your rulings, within the limit of the safety and well-being of your patient. Give a reason for everything if necessary, until it is seen that you know what you want and that you do not want anything that is unnecessary.

In large families there should be a room set aside as a hospital. It would be much better than tearing up a number of rooms, from time to time, for hospital purposes. But the contingency of illness is seldom provided for, even in the most methodical families.

The nurse is fortunate if she always has a room to be used for the patient only. All sorts of conditions will be met in the practice of nursing, and the nurse must be prepared to take what she finds in good part. Where a family is so restricted as not to be able to give a room up wholly for the care of the patient, they should be urged to send the patient to the hospital. Frequently the nurse can succeed in overcoming the prejudice against hospital care, where the doctor has failed.

A large room, in fact the largest room to be had, is the most desirable for a sick-room. It permits of more perfect ventilation, it allows occasional movement of the bed and change of scene, and the temperature can be better regulated than in a small room.

It should be *sunny*, that is, with a southern exposure, if possible. Even in cases where a dark room is required, a southern room is dryer and healthier than a room with a northern exposure. Then the bed can be darkened by screens, while the sun is daily admitted into the room.

There should be two or more windows, and both upper and lower sash should be movable. It is desirable to have two sets of window shades—one of white holland and one of dark green opaque stuff, unless there are blinds.

Bearing the above desiderata in mind, choose a quiet room. Especially if there is a shop in the neighborhood which emits a monotonous pounding, avoid it, if possible. Unless the neighborhood is uninhabited, choose a second-story room. The isolation will be worth the additional trouble. In any event, do not have the room above occupied. In cities, the higher

the room, the quieter it will be and the better will be the air supply.

To recapitulate, then, in order of importance: choose a room that can be well and easily ventilated, well heated and cooled, accessible to the sunlight, in a quiet location, and one that is not too small.

The furnishing of a sick room for infectious diseases has been given.[1] If the patient is likely to be sick some time, the carpet should be taken up and the floor thoroughly cleaned and dried before the patient occupies the room.

The necessary furnishing of a sick-room are a bed, a table ($2\frac{1}{2}$ ft. x 4 ft.), an easy-chair, a couch, and a four- or five-fold screen. More than this is a superfluity, and yet there may be a necessity for additional furniture. A commode-chair is sometimes essential, as well as other articles that cannot be anticipated.

The draperies in a sick-room should be removed, as there is no furniture that catches dust and infection quicker. If fabrics have to be used they should be washable, and screens can be improvised with sheets. In acute illness the pictures can be removed to permit the easy wiping down of walls, but when convalescence begins they may be restored in part, to relieve the cheerless appearance of the room.

If it is impracticable to remove the carpet, it can be cleaned with a dampened cloth, as before described.[1] Small rugs or, better still, small strips of carpet that can be removed daily and cleaned, are the best floor deadeners.

Unless the patient is insensible to the surroundings,

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[1] See chapter on "Disinfection."

something must be added to relieve the bareness occasioned by the removal of the furniture. The best articles are flowers and plants, and if not carried to excess, or of too odorous a character, they do no harm. They can be removed easily and changed frequently, but if the disease be infectious they need the same disinfection as other articles.

The sick-room must not be permitted to become a cause of mental depression to the patient, and the nurse must observe and counteract any such tendency. A cheerful nurse is the most cheering sight to the patient helpless by sickness, and the encouraging word or sympathetic expression is a remedy in itself.

Arrange the bed so that the light from the window will not confront the patient, or, equally bad, will not be reflected by a mirror. The patient may be too sick to complain, and the nurse must think for him.

Food of no kind must be permitted to remain in the sick-room. Remove all food and soiled dishes from the room at once. The custom of keeping something handy for the patient to take at any time is a wretched practice.

Remove all unpleasant sounds as far as possible. A creaky chair, or rattling windows, etc., are noises scarcely noticeable in health, but to the sick, whose senses are all on the stretch, it may be agonizing. This applies to the lisping or whispering of conversation. It is much better to hold a conversation in a natural voice, in a low tone.

The clothing of the nurse should be reasonably free from starch. Stiff garments crackle and add an irritating sound, besides giving an unpleasant sensation to the patient when they may come in contact with him.

Beds will be treated in another chapter, but here it may be stated that preference should be given to an iron bedstead, where a choice is possible. A narrow, or single, bedstead is preferable to a double one.

For the convalescent who may be permitted to read, a book rest can be constructed, as shown in the cut (Fig. 65). It is a simple contrivance that can be made in half an hour by a joiner. The same applies to a shoulder rest.

A clock that does not strike or that does not tick very loud should be selected for the sick-room, and hung where the patient can see it. It is a great satisfaction to many patients to know the time without asking it.

Care should be taken, if the patient reads, that the light should fall over the shoulder and not be in front of him. The night light, too, should be arranged, if possible, not to come in range of the patient's vision. If this is not possible, then the light can be screened. A better night light than a gas-jet turned low, is a small lamp. A kerosene light should not be turned too low. Have a small light and keep the usual flame. See that the light does not flicker. This will often create a nervous condition in a sick person, without his being able to give the cause for it. The vibrating light creates a sympathetic uneasiness and response from the sensitive nervous system.

The interrogation mark should be prohibited from the sick-room. I have had invalids tell me that Mrs. —— would make an excellent nurse if she did not ask so many questions. The nurse must recollect that sick persons are not usually capable of judging what is best for them, or even what they want. The nurse

must do the thinking and not ask for the opinion of the patient. If the patient makes a request or offers an opinion, then it should be respectfully listened to and heeded, if it be reasonable.

Sometimes the wall covering of the sick-room is antagonistic in color or design to the taste of the patient. A view that is constantly before a patient must not be hateful to him. In nervous and sensitive patients it will undoubtedly influence the course and results of the disease. If this is discovered by the nurse it is very easy to get a piece of muslin, of some neutral color, and make a wall hanging of it. An olive green, French gray, or wood color will usually be acceptable.

A hand atomizer is a convenient instrument to have in the room, filled with a simple cologne. It is a proper instrument to belong to a nurse's armamentarium, and then she will know it to be reliable. Sometimes a puff of atomized cologne, about or near the bed, is very grateful to the patient, and helps to neutralize the sick-odor.

These matters may seem very minute, but it is the sum of little things that makes the capable and acceptable nurse. The preparation of the sick-room and its proper care are among the nurse's chief duties, and physicians appreciate the aid that is given them in these matters.

In a hospital ward the supplies are fixed by rules, and the nurse is not responsible for them. The apparatus and furnishings of a hospital ward should be as few and simple as possible. Filling up a hospital ward with bric-a-brac and ornamental fabrics is a mistake. The same objection applies to this in a hospital ward as in a private sick-room. All the furniture

should be of a kind that can be washed, therefore upholstered furniture is not admissible. Cushions for chairs can be made of the best quality of hair that will stand steaming, and then at regular intervals they should be sterilized by heat. Or they can be made of bran or sawdust and periodically destroyed.

A bed, a chair, and a small table is the individual patient's requirement in a ward. The table should be

FIG. 65.—BED TABLE AND PROP.

small (a top 18 inches square) and have a shelf underneath. A shelf is better than a drawer, as there is always an opportunity to put food, and undesirable articles in drawers that may go unnoticed for some time.

A few folding screens should be provided for each ward. By using brass rods the screen can be made of muslin and frequently changed. Such a screen is useful sometimes by wetting it with a disinfectant or deo-

dorizer when these substances are needed. They should be made as light as possible, and not more than fourfold.

A bed table (Fig. 65) made of a board twelve inches wide, with the legs at either end, so that it can be stood across the bed, and high enough to be clear of the bed, is a very useful article of furniture. It can be used for the patient's meals, and to hold anything that may be used by the patient. When not in use it can be placed at the bottom of the bed.

As far as possible, the vessels used in the wards should be of china or glass. Any absorbent material, such as wood or wood-pulp, must not be used. They soon become saturated and filthy.

CHAPTER XXVIII.

BEDS, AND BED-MAKING.

THE *bed* is the important article in the sick-room. It is surprising how little attention is given to the place a person spends one-third of his life upon in health. In the case of an invalid, who spends all of the time in bed, its importance is correspondingly increased.

The *bedstead* should be preferably of iron (Fig. 66). The advantage of iron bedsteads is the possibility of cleaning them with facility. They have fewer joints for dirt and infection to deposit, and they are open and offer less resistance to the circulation of the air (ventilation). The only objection to them is their appearance, which is cheerless, but this is largely due to habituation.

The best bedstead for a sick person is of iron, with the mattress of woven wire, upon a mattress frame fastened to the bedstead and adjustable. The side bars should be of round or angle iron and not of wood. The height of the bed to the top of the wire mattress should be not less than twenty-two inches, and considerably higher than the ordinary bed. This is an advantage in preventing stooping of the nurse in the care of the patient, and of the doctor in making his examinations. It also allows cleaning underneath the bed

with greater ease. The bedstead should not be less than three feet in width, or more than three and a half feet.

In the case of illness that promises a long period, it will pay to purchase a bed of this kind, if there is not one in the household. Folding iron beds are made that can be folded into a small space when not in use, and that have all the advantages of iron beds.

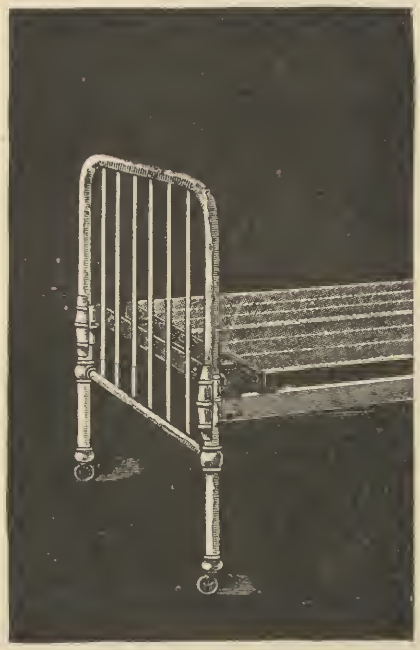

FIG. 67.—IRON BEDSTEAD.

Bedsteads should have *castors* of sufficient size to make the moving of the bed an easy matter. If they do not work well, or squeak, a drop of oil allowed to run on the part where the friction comes will remove it.

Bed-bugs should be watched for constantly. They make their hiding-place in the joints of the bedstead, and it is a good precaution to make a periodical search with a toothpick. The least sign of a bug should lead

to a thorough saturation of the joints with a 1 to 1000 solution of bichloride. Varnishing the bed, and particularly filling the joints with varnish will destroy them.

The *mattress* should be made of the best quality of long-drawn, South American horse hair, and be thoroughly dusted by running it through a dusting machine several times. Where the nurse has the selection of the mattress from a number in the house in use, select the newest one. A mattress should not be too thick. For a single bed a hair mattress weighing twenty-four pounds is ample.

It is a good plan to cover the wire springs with a piece of canvas or several layers of burlaps, upon which the mattress can rest. Whatever is used about a bed *should be clean.*

Mattresses are frequently made in sections, the purpose being to change the sections and equalize the wear. Patients, however, sometimes complain of the cracks, and it is more difficult to make a smooth bed than with a whole mattress.

A *straw mattress* has the great advantage that it can be frequently renewed. If made of well threshed oat straw, it makes a very comfortable bed and is much preferable to an old dirty hair mattress.

Excelsior has the advantage of cheapness. Cotton in any form should never be used for a mattress. Feather-beds are an abomination. They are hot, damp, absorbent, and have very properly been likened to a great poultice. Occasionally there are persons who have become so accustomed to sleeping on feathers that they decline to get along without them. In such cases there should be two feather beds, to allow of one airing while the other is in use.

The *pillows* of which there may be two, should be of feathers not filled so as to be hard, and where there are two, one of hair hard enough to be a firm support for the head. In fevers and where there is much perspiration, the pillow should be of hair.

In some surgical cases it is necessary to have a flat bed, and then the mattress should be a thin one, and have several boards underneath it. For the purpose of ventilation the boards can be bored full of holes.

A *mattress protector* is a good provision to make for saving the mattress. A layer of bat may be enclosed by cheap, coarse muslin, and "tacked" every few feet to hold it together. This can be destroyed every few days and replaced by a fresh one, or if made with greater care can be washed.

The sheets should be made of cotton. In very hot weather linen sheets are cooler, but as a rule they absorb moisture so quickly as to chill the patient. Sheets should have no seams in them. They should not be so wide as to be in the way at the edges of the bed. $\frac{7}{4}$ sheeting is best adapted for single beds. As a rule a draw sheet will be required.

The *blankets* should be single and not too heavy. Two and a half pound blankets (single) of a soft texture are preferable to heavier ones.

A *counterpane* should be used if one can be had light enough. The heavy counterpane with raised figures is not adapted for a sick person. It should also be narrow enough to prevent it interfering with the necessary bed manipulations.

Bed-making is an art that every nurse should be perfect in. She should be deft and quick, for to the patient sitting up awaiting the bed-making, the time occupied

by her cannot be too short. The *lower sheet* should fit the mattress tightly, without wrinkles, and to prevent its wrinkling it should "draw" from every corner equally. It should be tucked well in on the sides. When the patient is restless, a good precaution is to pin it to the mattress with safety-pins. The protector should be under the lower sheet, and when there are body discharges, a piece of rubber cloth may also cover this. No woollen fabric should be used under the body.

The *draw sheet* will obviate the necessity of any rubber protection underneath the lower sheet. This is a piece of rubber cloth about $2\frac{1}{2}$ by 4 feet in size, reaching from the pillow to the knees of the patient. Over this the cotton draw sheet (an ordinary sheet doubled) may be placed, and tucked in at the sides. This may be pinned also, to prevent its displacement. Be careful not to have a seam under the patient's back; therefore, have the hems either at the foot or side of the bed. When rubber is not available for a draw sheet, heavy brown wrapping paper may be used. The objection to it is the tendency to crackle, and its poor conduction of heat. As soon as there is no further necessity for protection, remove both draw sheets, as the bed is more comfortable without them.

The *upper sheet* should be left far enough up to turn over the blanket, and at the foot it should be tucked in with the lower sheet. Care should be taken at the foot of the bed to leave space enough for the patient's feet to be moved about with comfort.

The *blanket* and *counterpane* come next. The upper edge of the blanket can be protected by the sheet and the counterpane by being folded backwards. Take care that the woolly blanket does not come in contact with

the skin. In some diseases it may be advisable to have the patient between the blankets, as in rheumatism.

Down coverlets are not advisable on account of the heat they retain, and the difficulty of disinfecting them. An extra blanket should always be ready for use. It is often needed in the night.

The *changing* of bedding requires some ingenuity and study. The chief object should be to occasion as little fatigue and discomfort to the patient as possible. Know thoroughly what you are going to do before you start at it. The nurse should be able to change the sheets and blankets without assistance.

To change the lower sheet or draw sheet, have the patient lie on one side. Roll the sheet up lengthwise to the body. The clean sheet should then be laid out on the same side with the remainder in a roll beside the other. See that it is smoothed out and make the proper allowances for the other side of the bed. The patient may then be turned over on to the clean sheet, the soiled sheet being removed and the clean one unrolled. If the patient cannot be turned, the two sheets can be gently worked underneath the body. If the bed is arranged with a crane above it the patient can assist by raising himself in some degree.

The upper sheet can be changed without any exposure. Free the clothes at the foot of the bed and spread the fresh sheet and blanket above the soiled ones and afterward the latter can be slipped from underneath. It is quite useless to expose any part of the person in changing any of the bedding. It is a poor custom in sickness to use the upper sheet for a lower one. Always have the smoothed sheet below.

Fresh bedding should always be spread out and aired

before using it. It is a good plan to warm it to remove the dampness. Damp bedding is apt to cause a relapse, and nothing chills a patient sooner than a fresh, damp sheet.

When the bed gets to feeling unpleasant to the patient, changing the position of the sheets and airing the bed by lifting the clothes and replacing them, is refreshing. It is a marked advantage to have two beds, so that one may be aired and made up while the other is in use.

Change the bed linen frequently, even if it is not soiled. This is especially necessary with pillow cases. It is refreshing to a patient to have the pillow shaken up and a clean case put on. By placing a pillow in the sun for half an hour, the feathers swell up and are revivified. In moving the patient's head be careful not to let it drop.

To raise the upper part of the body, fold a blanket, and place it underneath the upper part of the mattress. This is better than propping up with pillows. Sometimes the patient is relieved to have something against which he can push with his feet, to prevent him from slipping down in bed. A hassock, or inverted chair, will answer the purpose.

There are various devices for invalid beds, but they are usually quite complicated, and are seldom available to the nurse in private houses. She must exercise her ingenuity to adapt what is at hand to her needs.

There is nothing more distressing to a patient than crumbs in a bed. After each meal the lower sheet should be brushed off.

Rubber air-cushions are sometimes serviceable. They should be cloth-covered. Air and water mattresses are

sometimes required. An air mattress should not be filled too full. Water mattresses must lie in a box. The water must be changed occasionally, and care must be taken that the temperature of the water is not too hot or too cold before the patient occupies it.

Beds in hospital wards should all have a uniform appearance. After being vacated in the morning, the bedding should be arranged so that the air can reach every part of it, and be left in this way until they are made up for occupancy in the evening. On two days in the week they should be made up in the morning for inspection. All soiled bedding should be changed, and clean pieces put in the proper place for making up.

A bed that is made up very soon after being vacated in the morning, will emit a decided body odor when the covers are thrown back in the evening. It is an indication of improper ventilation. If the mattress is given a half roll at the head of the bed, and the sheets and blankets are uniformly folded at the foot, the ward has a neat appearance. The physician can then see every piece of the bedding at a glance, and satisfy himself of its cleanliness. Made-up beds should have a flat top and should not be lumpy. This can be done by rubbing a straight-edge (of board) over the top of the bed after it is made.

Patients are fond of putting things away in the bedding, under the mattress, etc. This the nurse must not permit, not even articles of clothing that are clean.

CHAPTER XXIX.

OBSERVATION OF SYMPTOMS.

A SYMPTOM is a sign, or an indication, of disease or injury.

The faculty of *observation* must be cultivated by a nurse, in order to make her service of value as an aid to the physician. Some persons have this faculty acutely inborn. Others must cultivate it. This quality of observation must extend to the symptoms presented by the patient, and then what is observed must be correctly interpreted, and precisely reported to the physician, either verbally or in writing.

Observing accurately and describing precisely and intelligently, is the chief characteristic of the well-trained nurse. No symptom should escape her observation, and she should have the capacity to determine whether certain symptoms are grave or important,— whether the presence of a physician is required or not.

The nurse has a better opportunity to observe the symptoms than the physician, on account of her constant association with the patient. She sees her patient under all sorts of circumstances, and if her powers of observation are well developed and she can impart what she sees, she is the physician's most valuable assistant.

Exaggeration or depreciation of symptoms by a

nurse is wholly to be condemned. Report precisely what you see—no more, no less. Truthfulness is under no other circumstances more important, for upon it may rest life or death. Do not guess. Stick to facts, whether they be disappointing or not.

In order to report symptoms intelligently, a knowledge of diagnostic terms or the terms of symptomatology must be acquired. Do not go out of your way to use a technical term, even if you know it to be correct, but when ordinary terms will suffice, use them.

If you have an opinion regarding the disease of your patient, keep it to yourself. If the physician wants your advice, he will ask for it. As a rule, the physician wants facts and not opinions, therefore, confine yourself to facts. Above all, do not talk about your patient to the friends—that is, do not air your opinions in the absence of the physician. You may be right or wrong, but it is not the nurse's function to diagnose or treat the disease. You are employed to carry out instructions and to observe and report what you see and what occurs. Many a nurse has ruined otherwise bright prospects by talking too much.

Symptoms may be divided into three classes: (1) *subjective* symptoms, or those which are appreciated or felt only by the patient; (2) *objective* symptoms, or those which are evident to others; (3) *simulated*, or *feigned* symptoms, which are symptoms "put on" by the patient, for some reason to deceive.

Subjective symptoms, as they appeal to an outsider, depend wholly upon the statement of the patient. They cannot always be relied upon, and although the patient may have no intent to deceive, through fear, anxiety, or under the supposition that their condition is worse

than it is, they exaggerate their feelings. Even if the nurse is quite certain of their incorrectness, the patient's statements should be reported just as they are given. If a reasonable doubt exists in the mind of the nurse, it is proper that the physician should be informed upon what it rests.

Subjective symptoms are usually accompanied by some outward sign, or symptom, and where they are entirely subjective, they must always be regarded with suspicion. In mental disease, however, the symptoms are often entirely subjective, especially in chronic cases where the bodily functions have been fairly well restored.

Careful observation will soon reveal to the intelligent nurse the value of subjective symptoms. In the symptom of pain, which is the one usually complained of and is always subjective, watching critically while the attention is diverted will show any weak points in the statement. As an instance, if a patient complains of exquisite tenderness of some point in the body, by diverting the patient's attention in some manner while making pressure upon this point, its genuineness will be shown. If it is actual, the pressure will cause the usual signs of pain, and if not true, it will go unnoticed. The degree of tenderness will also be indicated.

Pain, although subjective, is a valuable symptom, but is usually accompanied by other signs that are objective. The absence of pain in disease is not always favorable. We know where there is pain that there is the power of reaction. In collapse and shock there is no pain. Pain ceases at the approach of death.

Pain is of different qualities and these are characteristic, so that by the quality of the pain, we can distinguish the disease. Thus, in pleurisy we have the

stabbing pain, in colic spasmodic pain, etc. Pain may be lancinating, or stabbing, boring, stinging, burning, etc. Pain may result from inflammation, or neuralgia. In the former case it is increased by pressure and in the latter relieved by it.

Loss of feeling in a part is called *anæsthesia*, and increased sensibility is *hyperæsthesia*. Pain may indicate the locality of disease, but this has exceptions. The beginning of a spinal disease (tabes dorsalis) is indicated by pain in the legs; some forms of heart disease, by pain in the shoulder, etc.

Of *objective* symptoms, the most important indications are afforded by the pulse, the temperature, and the respiration. The normal condition of the above three "vital signs" has been studied under their several heads.

In noting the *pulse* the manner of the nurse should be quiet and unobtrusive. By directing the patient's attention to it, the pulse rate is increased. The frequency of the pulse is to be noted. The radial pulse at the wrist, the artery on the front of the wrist near the thumb, is the best place to feel the pulse, although there are several places where the arterial beat can be felt. It is advisable to count the pulse for a full minute, but if this is impracticable, counting it for half a minute and doubling the number will suffice. Besides the frequency of the pulse, its character should be noted; whether *quick*, or *sharp*, *full*, *small*, *compressible*, or *incompressible*. An *irregular* pulse is where the intervals between the beats are of unequal length. An *intermittent* pulse is the loss of an occasional beat. This loss may occur with regularity, so that every fifth or tenth or twentieth beat may be lost. This is

not always a morbid sign, for it is frequently found in persons having perfect health. A *dicrotic* pulse is one in which two beats occur at each heart's contraction. There will be a strong beat immediately followed by a secondary beat, like an echo. Be careful not to count this secondary beat. Occasionally the pulse in the two wrists will not beat synchronously, that is, they do not beat in unison. This is a *retarded* pulse. In addition to these changes from a normal pulse, it may have characters which can be described by *jerking*, *bounding*, *throbbing*, *thready*, *flickering*. Unless there is a change in the character of the pulse between the visits of the physician, the nurse is only expected to give the frequency of the pulse at the stated times. Another precaution is not to feel the pulse very frequently unless there is some reason for it. It tends to make the patient anxious.

The *respiration* can usually be counted with sufficient accuracy by noting the rise and fall of the bed-clothing, over the chest. The patient should not talk during the time of counting respiration, but it is usually not necessary to call his attention to it. Besides the rate, the character of the respiration should be noted,—if the respiration is *easy*, or *labored*. Difficult respiration is termed *dyspnœa*, and is due to various causes. It may result from a reduction in the lung capacity, or from some impediment of the air passages. It should be noted whether the breathing is *regular* or *irregular*, and whether the respiratory act is chiefly made by the diaphragm and abdominal muscles (*abdominal breathing*), or by the chest muscles (*thoracic breathing*).

In diseases of the lungs, if there be pain the pleuræ

are involved. If the disease is in the air cells the breathing is very rapid, but comparatively easy, but if the bronchial tubes are affected, there is more effort required. A respiratory symptom that indicates a serious or fatal condition, is short and light inspirations, gradually increasing until they become a "sigh," long and deep, and then returning to the short ones, this change occurring two or three times in a minute. This is called *Cheyne-Stokes* respiration.

When there is disease in the lungs or air passages, there are sounds produced in addition to those of health, and are caused by the presence of fluid in the air passages, or air cells. These sounds are known as *râles*, and are sometimes loud enough to be heard in any part of the room. They should be distinguished from the rattling in the throat caused by mucus.

The detection of sounds in the chest by listening to the natural breathing, is called *auscultation*. The resonance of the chest ascertained by tapping the chest walls, is called *percussion*. The measuring of the circumference of the chest to detect swellings is called *mensuration*.

Diseases of the lungs are usually accompanied by cough, which is a reflex action (automatic) caused by some irritation of the air passages. The matter that is coughed up is called *sputum*. The coughing up is called *expectoration*. When there is no expectoration the cough is said to be dry. If the *sputum* contains pus it is *purulent*. It may also be described as *thick*, *yellow*, *ropy*, *frothy*, *bloody*, *brick-dust*, *rusty*, *greenish*, *offensive*. The different character of the sputa either indicates the disease, or the stage of the disease.

The nurse should observe what time of day the cough

is the worst, when expectoration is the more copious, the character of the cough, whether *hard*, *loose*, *short*, *incessant*, or *paroxysmal*.

The *temperature* is usually taken in the morning and evening.[1] There may be, however, occasion for taking it more frequently. Should a patient complain of cold, or become unusually flushed, or should there be any marked change in his condition, the nurse had better take the temperature. The patient may have a chill and the temperature will be found to be very high. When this is the case the temperature should be taken every hour until the doctor arrives.

The nurse should be sure that the thermometer is correct. If it is a new thermometer, it should be tested with one that is known to be accurate. It can be placed side by side with the correct instrument in the mouth, and the differences noted. A thermometer may be accurate at 98 degrees F., but a degree out at 104 degrees F. Another way to test is by placing the standard and new thermometer in a graduate with water, and gradually raising the temperature of the water, noting the difference in the mercury as it ascends. Thermometers can be bought with the certificate of a test, but unfortunately these are not always reliable.

After using the thermometer and recording the temperature upon the chart or bedside notes, the instrument should be carefully washed and dried, and the column shaken down. Hold the thermometer firmly between the thumb and fore-finger and strike the ball of the hand upon the knee. If the register is obstinate, it

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[1] See chapter on Temperature.

can be depressed by holding the thermometer firmly and rapidly revolving the arm in a circle. A good plan is to have two thermometers on hand. The length of time necessary to expose the thermometer depends upon the thickness of glass in the bulb. The best rule is to expose the thermometer in the axilla ten minutes, and in the mouth, rectum, or vagina five minutes. In the case of infants, the temperature should be taken in the rectum. The thermometer should first be oiled and inserted for two inches. If the rectum contains fæcal matter, the thermometer will meet with resistance. It should then be removed and the rectum cleansed by an enema, afterwards waiting for fifteen minutes until the temperature becomes equalized.

In a *hospital patient* observation of symptoms should begin immediately. The general appearance, attitude, and expression, the manner or disposition, indications of weakness, peculiarity of gait, deficient power in the arms or legs should be noted. These observations can be reported to the physician when he is making his physical examination and may be of use.

Bodily affections are indicated by the attitude, as the patient assumes the easiest one, as a rule. Thus the patient lies upon the side of an affected lung. The knees drawn up suggests abdominal trouble. Lying with the head raised suggests heart disease, etc.

The *physiognomy*, or *facial expression*, is an index to many conditions. The experienced nurse gets an intuition that is very useful in interpreting this mirror of sensation and emotion. A bluish or purple appearance about the nose, lips, or cheeks, indicates imperfect oxygenation of the blood and is frequently associated with heart disease. A contracted appearance about the

mouth suggests nausea. In diseases of the lungs there may be a red spot on one cheek (hectic), very often on the same side of the affected lung. In Bright's disease there is a waxy appearance of the skin. In jaundice the skin is yellow. In opium habitués the face has a parched, sallow appearance, and in fevers it is dry and flushed. A pinched and anxious expression indicates a serious condition. A dull, apathetic, stupid face (except in dementia) suggests a grave disorder.

Change in the *body weight* is of importance, particularly in chronic diseases. In acute insanity, increase in weight usually precedes mental improvement. Increase in weight without mental improvement is an unfavorable sign. Where it is possible the patient should be weighed at regular intervals, attention being given to the clothing, that it be uniform at all the weighings.

The condition of the *tongue* should be observed, and especially any changes in the sensation of the tongue, difficulty of moving it, etc.

The condition of the *skin* may be described as *dry*, *moist*, *clammy*, *hot*, *flushed*, *cold extremities*, etc. Eruptions should be carefully noted, and any ulcers, or old or recent scars. During the patient's bath the condition of the whole surface can be ascertained.

The eye affords many indications of disease.[1] In congestion of the brain from any cause, the eyes are turgid. Protrusion of the eyeball is a symptom to be noted. Rolling of the eyeballs from side to side is a common symptom in infants. Squinting is an unfavorable sign. The state of the pupil should be care-

[1] See chapter on "Sight and Hearing."

fully observed; whether unequal, contracted, dilated, or irregular; also whether it is immovable, or does not respond to light. The nurse should always observe and report any complaints of flashes of light, moving spots, double vision, half-sight (hemianopsia), or pain from light.

During the course of treatment, the nurse must note any new symptoms. Any eruption or rash appearing must be carefully observed. The locality in which it first appeared, its course, the changes in its development, with the time of each,—all have a significance to the physician, whose diagnosis may rest upon the nurse's report. The sensations or irritations that can be described, as *burning*, *tingling*, *itching*, *crawling*, *numbness*, etc., should be carefully observed with regard to its locality and progress.

Changes in the special senses have been referred to in the chapters devoted to them.

CHAPTER XXX.

THE RECORDING OF SYMPTOMS (CLINICAL RECORDS)

A *clinical record* is a recorded history of a disease in an individual patient, giving the symptoms in the order of their occurrence.

A *chart* is a delineation of the course of certain symptoms in map form, in order to easily compare the daily changes.

The advantages offered by an accurate written record of symptoms can hardly be over-estimated. It gives the physician attending the patient the opportunity to see what the course of the disease has been since his previous visit, and gives the symptoms in the order of their occurrence. It makes a record of the disease on the spot, and therefore its accuracy is unquestioned, as it does not depend upon memory.

A nurse in private practice should provide herself with forms for bedside notes, and charts, and not depend upon the physician to provide them. They can now be purchased in all medical stores. It is well to have all the charts and forms of one size, a convenient size being 8 x 10½ inches. A board or pasteboard of the proper size to hold the sheet out flat, with a clip at the top, makes a convenient hand-rest for writing, and preserves the sheet flat. The nurse should get in the

habit of making her record upon the form finally. It is a bad practice to keep notes upon a separate sheet and then transcribe them. Sometimes it is forgotten, or the notes are lost. It is a good plan for a nurse to own a *good* fountain pen, and have it fastened to the person. When a symptom is observed, or food or medicine is given, make the record in ink at once upon the final sheet. It saves labor and frequent mistakes.

For a complete clinical record, the following forms are required :

(1) History form.
(2) Ward, or bedside, notes.
(3) Temperature chart.
(4) Weight and sleep chart.

The most important of these forms is the "bedside notes." This should contain a column for the date, and columns for the hour, temperature, pulse, respiration, urine, and stools. The remaining and larger space should be devoted to notes, and these comprise a record of every occurrence that has a relation to the patient. The physician may also record his directions in this column. The charts can afterward be made up from the bedside notes.[1]

The weight and sleep chart may be combined. This is very useful in prolonged and wasting diseases and in some forms of acute insanity. The changes in weight indicate the progress of the case in some diseases better than any other symptom.

If the nurse does not have any forms at hand, sheets of foolscap can be ruled with a pencil, to answer the

[1] A typical record upon the sample page (reduced upon the following page), gives an idea of the scope of ordinary bedside notes.

WARD NOTES.

Name, Richard Roe   Ward,   Commencing June 22d   1896.

DATE.	HOUR. A. M.	HOUR. P. M.	TEMP.	PULSE.	RESP.	URINE.	STOOLS.	DIET, MEDICINES AND NOTES / PHYSICIAN'S DIRECTIONS.
22	6		100.2	96	18			Visited by Dr.——. Sweating freely.
	6½					℥iv		Milk ℥vi. Complains of frontal headache. Some nausea.
	7^{20}						1	Stool small and serous. Some tympanites with pain.
	7^{30}						1	Larger stool of the same character.
	8^{10}							Milk, ℥iv. Complains of nausea.
	9^{30}					℥iv		Dark colored, and deposits urates.
	10^{45}							Slept ½ hour. Headache relieved.
	11							Medicine given.
	11^{30}						1	Character the same. Sweating freely. Room temp. 65°
		12^{10}	101.8	98				Visited by Dr.----.
								If temperature reaches 102, give sponge bath. R.W.W.
		1	102.2					Sponge bath to extremities and trunk.
		1^{20}					1	Less serous, but small amount. No griping.
		2^{10}				℥iii		Dark coloured.
		3						Milk ℥viii.
		3^{45}						Slept half an hour. Awoke confused. [illegible]
		[illegible]	[illegible]					[illegible] Sponge ba[illegible]

FIG. 67.—FORM FOR BEDSIDE NOTES. REDUCED FROM A FORM 8 x 10½ INCHES.

purpose very well. In any case, do not fail to adopt some methodical form of recording.

The *temperature* should be recorded in the "notes" whenever it is taken, but in making up the chart, use only the morning and evening temperature. If there is any decided change from its usual course, the notes should indicate its relation to other symptoms. Thus: "3 P.M. chill commenced"; "3.05 P.M. temp. 105."

It is better not to let the patient have access to the nurse's notes and charts. The habit of a patient studying his own case is to be condemned, and if the clinical notes are before him he is tempted to read them.

The *pulse* should have its rate recorded, and at the beginning of the record, the other characters of the pulse should have a record. If there is no subsequent record of pulse quality aside from the rate, it may be assumed that it has not changed. Sometimes the pulse is modified by pressure upon the artery or by position. The nurse should bear this in mind.

The points to note in taking the pulse are:

(1) Its frequency.
(2) Its regularity.
(3) Whether intermittent.
(4) Its size (full or small).
(5) Its strength and compressibility.
(6) Dicrotism.

If any change in the quality of pulse is noted, it can be recorded upon the same line with its rate, thus: "3 P.M. 106°, compressible and irregular."

The character of the pulse depends upon the action of the heart and the condition of the arterial walls. The latter, however, is not changeable during the course

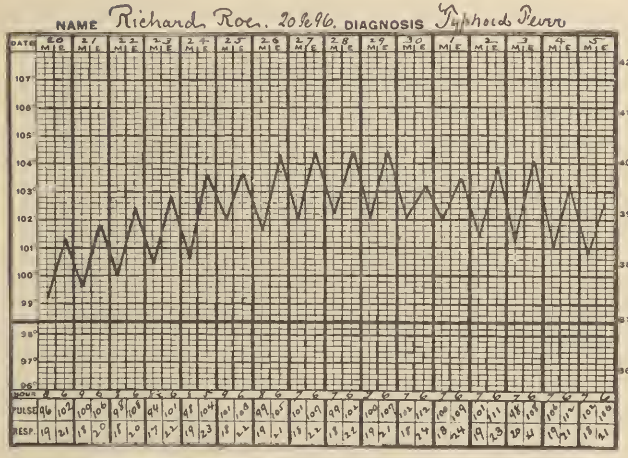

FIG. 68.—TEMPERATURE CHART REDUCED FROM 5 x 8 INCHES.

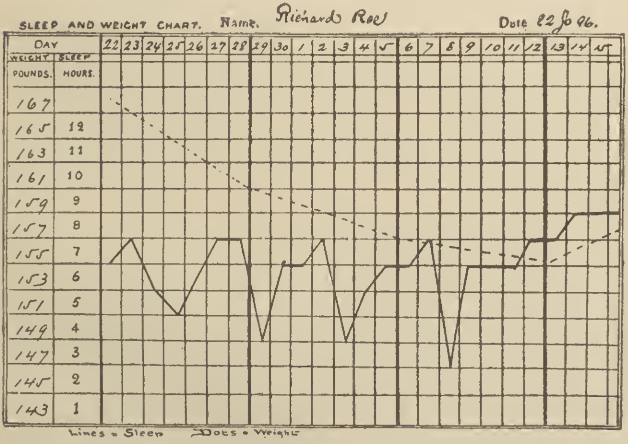

FIG. 69.—SLEEP AND WEIGHT CHART (REDUCED.)

of an ordinary disease. If the pulse should become so weak as not to be felt at the wrist, the nurse must listen to the heart's action over the apex on the chest walls. Sometimes it is difficult for a nurse to count a pulse that exceeds 130. A good plan is to count tens, repeating them and remembering the number of them. Even *thinking* the full number takes more time than can be given in counting a rapid pulse.

The *tension* of the pulse must be considered, as it indicates the arterial pressure throughout the body. If by squeezing the artery it cannot be flattened out between beats, the condition is expressed as "high arterial tension." This should be distinguished from *arterial sclerosis*, in which the walls of the arteries have become hard ; or from the *atheromatous* arteries of old age, in which there is a mineral deposit in the walls of the arteries. The effect of medicines or food upon the pulse should be noted by the nurse ; also the effect of baths, massage, or electricity. Always recollect that the pulse is an index of the blood circulation and its organ, and its importance will be appreciated.

The relation of the pulse to temperature and respiration should be observed. If the temperature goes down and the pulse rate increases, it is a sign of serious trouble.

In taking the respiration, the nurse must wait until the patient is at rest. If the rate of breathing was taken after the patient had been exerting, or had been moved, it would be increased. The average number of respirations in an adult is eighteen, and in a child of one year twenty-four. In some diseases the respirations become very rapid. If they exceed forty it is a serious indication. Usually in diseases of the lungs

the rapidity of breathing is out of proportion to the pulse rate.

Stertorous breathing is a noise like a snore made with each respiration, and the cheeks are sucked inwards at the inspiration. This is the usual respiration in coma, and in paralysis, or apoplexy.

The terms used in describing the character of the respiration are:

(1) *Stertorous*, a blowing sound.
(2) *Dyspnœa*, difficult breathing.
(3) *Orthopnœa*, the necessity of sitting upright to breathe.
(4) *Abdominal* respiration.
(5) *Thoracic* respiration.
(6) *Cervical* respiration—great action of the neck muscles in breathing.
(7) *Cheyne-Stokes* breathing.
(8) *Hiccough*, a spasm of the diaphragm.

Cough may be designated as:

(1) *Dry*, or *hollow*, or *hacking*.
(2) *Soft*, *deep*, or *loose*.
(3) *Short* and *sharp*.
(4) *Barking* or *hoarse*.
(5) *Whistling*.
(6) *Paroxysmal*.

Expectoration may be characterized as:

(1) *Mucous*, in catarrh and bronchitis.
(2) *Purulent*, in severe bronchitis in its later stages.
(3) *Rusty*, in early and middle stages of pneumonia.
(4) *Bloody* and *muco-purulent*, in phthisis.
(5) *Putrid*, in gangrene of lung.

In recording the passage of the *urine*, it is a good plan to state the amount. It is a simple matter to

measure it if a graduate is kept for that purpose; but if not, an ordinary tumbler, which holds six fluid-ounces, can be used, and a fair estimate made of the quantity. In the column for urine, instead of the simple line indicating a passage, the ounces can be stated, thus, ℥ iv. Frequently the physician requires an examination of the urine, and will direct how this is to be done. For ascertaining the reaction, litmus paper is used. If blue litmus is turned red by immersion in urine, it is *acid*. If red litmus is turned blue, it is *alkaline*. If it changes neither red nor blue it is *neutral*.

The specific gravity is tested by the immersion in the urine of an instrument called a *urinometer*. This has a scale marked upon a stem, and as the instrument floats in the urine the mark at the surface of the liquid is the specific gravity. It is compared with water in 1000 parts. If the urine in 1000 parts is ten parts heavier, the specific gravity is said to be 1010.

The color of the urine should be stated. The usual terms used to designate colors are: *very light*, *light*, *amber* (the normal color), *dark*, *very dark*, and *bloody*.

It is sometimes necessary to get the total quantity of urine passed in twenty-four hours. If the urine is cloudy or opaque, the fact should be recorded or reported to the physician. In fever, the urine frequently deposits a brick-dust sediment upon cooling. This is uric acid, and is not at all alarming. If the urine has an unusual appearance, or should change in its appearance during the course of the disease, a sample should be saved for the physician to see. The nurse should always inspect the urine passed.

The character of the discharges from the *bowels*, al-

though usually not as important as the excretion from the kidneys, should never be overlooked. The stools may contain *blood*, *mucus*, *lymph*, *pus*, or *undigested food*. They may be *mucous*, *bilious*, or *serous* in character. When stools have the ordinary appearance, they are said to be *well-formed*.

The condition of the *tongue* depends very much upon the care the patient has, but the coating indicates the condition of the stomach, and its character should be noted. The tongue may be:

(1) *Pale*, as in anæmia.
(2) *Cold*, as in collapse.
(3) *Red*, in scarlet fever, gastritis.
(4) *Furred*, in indigestion, gastric catarrh, fever, etc.
(5) *Brown* or *black*, *cracked* or *fissured*, in low fevers.
(6) *Protruded with difficulty*, or *to one side*, in debility, apoplexy, paralysis, etc.

The *teeth* are covered with *sordes* in low fevers. They are loosened by salivation.

The *gums* are swollen, soft, spongy, in scurvy; they have a blue line along the edge in lead poisoning.

Spasm and *tremor* should always be particularly observed and reported, for its importance in diagnosis, or in indicating the progression of disease, is very great.

Spasm is of three kinds: (1) *Tonic*, when the muscles are rigid and fixed; (2) *clonic*, when there is a succession of contractions (jerks) without an interval; (3) *choreic*, when the movements are jerking and irregular, not controllable by the will.

The spasm may be *general*, affecting the whole body, or *local*.

In *tremor*, the distinction should be made between tremor that is *volitional*, that is, only occurring when

a movement is attempted, and *habitual* tremor, which is constant both during rest and motion. *Subsultus*, or jerking of the tendons of the wrist, occurs in a low state of fevers.

In recording spasm or tremor, note the time of commencement, the kind, body location, the progress, and time of ending. Always give the state of consciousness during it, and in fact any accompanying symptoms.

It is a convenience for the nurse to have some simple outline charts of the body, upon which can be located marks, rash, etc., with more accuracy than is possible by description (Fig. 70).

Finally, but not least in importance, good, plain penmanship should be an acquirement of the efficient nurse. The busy physician who must study over the hieroglyphics of the poorly written clinical record, is apt to be influenced in his estimate of the writer. Neatness in a record indicates the nurse's tendency.

At the close of a case, the nurse should arrange her notes, complete her charts, and present them all to her physician.

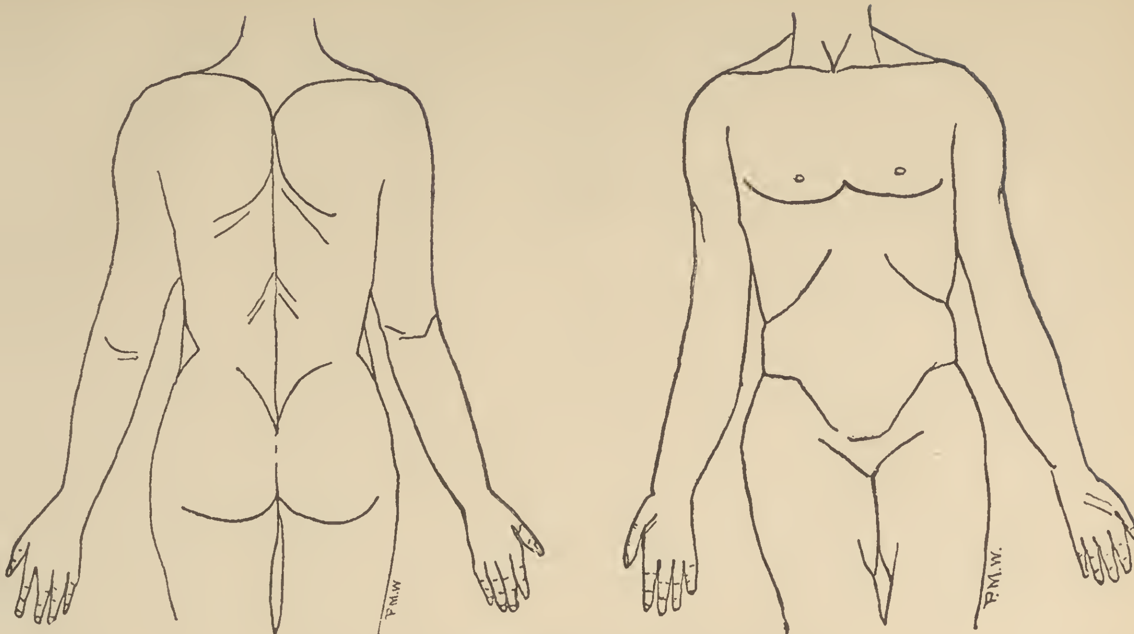

FIG. 70.—USEFUL DIAGRAMS FOR INDICATING LOCATION.

APPENDIX.

FORM FOR INITIAL EXAMINATION.

Name............Date............
Examined by Dr ....at......... M.
Pulse..........Temp..........Resp..........
Appetite..........Sleep ....
Nutrition...................
Respiratory system...............................
Circulatory system......................
Digestive system................
Genito-urinary system.....................
Cutaneous system..........................
Nervous system..................
General inspection......................
Mental state.....................
Development of present attack................
Urinalysis............................ ....
Blood examination...........................

(The above form can be made upon a sheet the size of other forms and charts.)

MEASURES, WEIGHTS, AND SYMBOLS.

APOTHECARIES' WEIGHT.

20 grains	1 scruple ℈		
60 grains	3 scruples	1 drachm ʒ	
480 grains	24 scruples	8 drachms	1 ounce ℥

APOTHECARIES' MEASURE.

60 minims ♏	1 fluid-drachm *f* ʒ	
8 fluid-drachms	1 fluid-ounce *f* ℥	
16 fluid-ounces	1 pint	O.
2 pints	1 quart	qt.
4 quarts	1 gallon	gal.

APPROXIMATE MEASURES.

1 teaspoonful	1 fluid-drachm
2 tablespoonfuls	1 fluid-ounce
1 wineglassful	$1\frac{1}{2}$ ounces
1 teacupful	4 fluid-ounces

THERMOMETER SCALES.

The *Fahrenheit* scale records the freezing point at 32° and the boiling point at 212°.

The *Centigrade* scale records the freezing point at 0 and the boiling point at 100°.

The *Réaumur* scale records freezing at 0 and boiling at 80°.

The rule for converting Fahrenheit degrees into Centigrade, is to subtract 32, multiply by 5, and divide by 9.

To convert Centigrade into Fahrenheit degrees, multiply by 9, divide by 5, and add 32.

The following table gives the relative values of Fahrenheit and Centigrade scales :

F.	C.	F.	C.	F.	C.	F.	C.
32	0	52	11.1	72	22.2	92	33.3
34	1.1	54	12.2	74	23.3	94	34.4
36	2.2	56	13.3	76	24.4	96	35.9
38	3.3	58	14.4	78	25.6	98	36.7
40	4.4	60	15.6	80	26.7	100	37.8
42	5.6	62	16.7	82	27.8	102	38.6
44	6.7	64	17.8	84	28.9	104	40
46	7.8	66	18.9	86	30	106	41.1
48	8.9	68	20	88	31.1	108	42.2
50	10	70	21.1	90	32.2		

Metric System.

The metric system is a decimal system of weights and measures used in France and Germany, and quite generally in science. The standard of measure is the *metre*. The standard of weight is the *gram*. The standard of volume is the *litre*. The divisions are all by decimals, 10's, 100's, etc.

Measure.

1000	metres	1 kilometre
100	metres	1 hectometre
10	metres	1 decametre
.1	metre	1 decimetre
.01	metre	1 centimetre
.001	metre	1 millimetre

Volume.

1000	litres	1 kilolitre
100	litres	1 hectolitre
10	litres	1 decalitre
.1	litre	1 decilitre
.01	litre	1 centilitre
.001	litre	1 millilitre

WEIGHT.

1000	grams	1 kilogram
100	grams	1 hectogram
10	grams	1 decagram
.1	gram	1 decigram
.01	gram	1 centigram
.001	gram	1 milligram

1 metre is equal to 39.37 inches.
1 litre is equal to 1 quart and ½ gill.
1 gram is equal to 15.43 grains.
1 minim is equal to .061 cubic centimetres.

The symbol for centimetre is cm., and for a cubic centimetre c.cm.

TABLE OF AUTOMATIC REFLEXES.

Name.	How obtained.	Effect produced.
Abdominal.	Sharp sudden stroking of front of abdomen from ribs down.	Contraction of muscles about umbilicus.
Ankle-clonus.	Press hand against the sole of foot, suddenly flexing it.	Spasmodic contractions of the foot.
Cilio-spinal.	Tickling skin of neck.	Dilatation of the pupil.
Jaw-jerk.	Striking the chin.	Spasm of the lower jaw.
Knee-jerk.	Striking knee tendon, leg hanging limp.	Foot jerked forward.
Laryngeal.	Irritation of the throat.	Cough.
Palatal.	Tickling of the palate.	Swallowing.
Palmar.	Tickling of the palm.	Contraction of fingers.
Periosteal.	Tapping bones of forearm or leg.	Sharp contractions of the muscles.
Plantar.	Stroking sole of foot.	Contraction of toes.
Pupillary.	Exposing retina to light.	Contraction of pupil.
Scapular.	Irritation between shoulder-blades.	Drawing up of shoulder-blade.
Toe.	Strong flexion of great toe.	Flexion of foot and leg.
Wrist-clonus.	Pressing hand backward strongly.	Jerking movements of the hand.

GLOSSARY OF TECHNICAL WORDS USED IN THIS VOLUME.

ABSORPTION, taking up.

ACCESSORY, secondary or assisting.

ACCOMMODATION, to make perfect vision.

ADIPOSE, fatty.

ÆSTHESIOMETER, instrument to test general sensibility.

AGRAPHIA, loss of ability to write.

ALBUMINOIDS, containing albumen.

ALIMENT, food.

ALIMENTATION, supplying food to the body.

ALLOTROPIC, change in property, without change in composition.

AMNESIA, loss of memory.

AMŒBOID, twitching movement.

ANÆMIA, deficiency of blood.

ANÆSTHESIA, loss of sensation.

ANÆSTHETICS, remedies to suspend sensation.

ANASTOMOSIS, to unite vessels.

ANTERIOR, front part.

ANTISEPSIS, exclusion of bacteria from the body.

AORTA, the artery from the heart.

APEX, the top, the point.

APHASIA, loss of speech.

APHONIA, loss of voice.

ARACHNOID, delicate membrane over brain.

ARMAMENTARIUM, articles for an outfit.

ARTICULATION, joint.

ASPHYXIA, lack of air.

ASSIMILATION, converting food to nutrition.

ASTIGMATISM, defective vision from unequal refraction.

ATHEROMA, hardening of arteries

ATMOSPHERE, the body of gases that surround the earth.

ATOMIZE, to make a spray.

ATTENUATE, to weaken.

AURICLES, upper cavities of the heart.

AUSCULTATION, listening to sounds of breathing.

AUTOMATIC, action without willing.

AXILLA, hollow of the arm.

BACILLI, rod-like bacteria.

BACTERIA, micro-organisms.

BEVERAGE, a drink.

BICHLORIDE, corrosive sublimate.

BICUSPID, mitral, valve of left heart.

BOLUS, a ball.
BRONCHI, air tubes in lungs.

CÆCUM, sac between large and small intestines.
CAFFEIN, active principle of tea and coffee.
CANCELLOUS, spongy.
CAPILLARIES, minutest blood-vessels.
CAPSULAR, enclosing like a sac.
CARAMEL, burnt sugar.
CARBO-HYDRATES, sugars and starch.
CARBONACEOUS, food containing oils and fats.
CARPUS, bones of the wrist.
CARTILAGE, gristle.
CASEIN, constituent of milk.
CENTIGRADE, a metric scale.
CEREALS, grain foods.
CEREBELLUM, small or hind brain.
CEREBRUM, the large brain.
CHART, form to illustrate.
CHLOROSIS, poverty of blood.
CHOREIC, irregular twitching.
CHYLE, fluid secreted by intestines.
CILIA, hair-like.
CIRCUMFERENCE, the distance around.
CLINICAL, relating to disease.
COAGULATE, to harden.
COCCYX, lower part of spinal column.
COLON, large intestine.
COMA, diseased sleep.
COMBUSTION, the operation of burning.
COMMA-BACILLUS, the germ of cholera.
COMMISSURE, connecting band.
CONDENSE, to reduce the bulk.
CONJUNCTIVA, lining of eyelids.
CONSTITUENT, part of.
CONTRACTILITY, the property of shrinking.
CONVALESCENT, a patient nearly recovered.
CONVOLUTION, twisting.
CONVULSION, a fit or spasm.
CORNUÆ, horns.
CORNEA, front of eyeball.
CORPUSCLE, a small body.
CORTEX, the rind of the brain.
COSTAL, relating to ribs.
CRANIAL, relating to the skull.
CREPITUS, crackling sound.
CRYSTALLINE LENS, the lens of the eyeball.
CUTICLE, scarf-skin.

DECOMPOSITION, decaying or rotting.
DECUSSATE, to cross each other.
DEGENERATION, destruction by disease.
DEGLUTITION, swallowing.
DEODORIZER, substance neutralizing foul odors.
DERMA, true skin.
DESQUAMATION, peeling of epidermis.
DIAGNOSIS, classification of disease.
DIAPHRAGM, the muscular wall between thorax and abdomen.
DIASTOLE, relaxation of heart.

DIATHESIS, constitutional tendency to disease.
DICROTIC, the pulse beating twice in succession.
DIGESTION, preparing food for assimilation.
DIPLOPIA, double vision.
DISINFECTION, destruction of bacteria,
DISTILLED, vaporized.
DUODENUM, upper part of small intestine.
DURA MATER, one of the meninges.
DYSACOUSMA, pain from noises.
DYSPEPSIA, disordered digestion.
DYSPNŒA, labored respiration.

EFFETE, worn out.
EFFUSION, pouring out.
ELIMINATE, to throw out.
EMBOLUS, loose coagulum of blood.
EMBRYO, a fecundated germ.
EMOTION, feeling.
ENCEPHALON, the brain.
ENDOCARDIUM, lining membrane of heart.
ENEMA, a rectal injection.
EPIDEMIC, disease spread by infection.
EPIDERMIS, the scarf-skin.
EQUILIBRIUM, steadiness.
ERGOTISM, disease caused by spurred rye.
ERUCTATION, belching.
ERUPTION, breaking out on skin.
EVAPORATION, changing to vapor.
EXCRETA, bodily discharges.
EXCRETION, throwing out, dis charges.
EXHALATION, breathing out.
EXPECTORATION, matter coughed up.
EXPIRATION, breathing out.

FACIAL, relating to the face.
FÆCES, excretion of intestines.
FASCICULI, small bundles.
FEMUR, thigh bone.
FERMENTATION, decomposition by micro-organisms.
FIBULA, small bone of the leg.
FLATULENT, gases in the bowels.
FLEX, to bend.
FOLIATE, tree-like.
FOLLICLE, a small secreting cavity.
FONTANELLES, openings in skulls of infants.
FOSSÆ, openings or cavities.
FUMIGATION, burning disinfectant.
FUNGI, vegetable, spongy.

GANGLIA, collections of gray nerve matter.
GASTRIC, pertaining to the stomach.
GERMICIDE, substance that kills germs.
GLUCOSE, a form of sugar.
GRAMME, about 15 grains.

HÆMATIN, iron in the blood.
HALLUCINATION, sensation without an object.

HECTIC, fever, reddening of the cheek.

HEMIANOPSIA, loss of vision on one side.

HEMIPLEGIA, paralysis of one side of the body.

HEMISPHERE, one-half of the brain.

HEPATIC, pertaining to liver.

HIBERNATION, state of inaction.

HUMERUS, arm bone.

HUMIDITY, moisture in air.

HYPERÆMIA, excess of blood.

HYPERÆSTHESIA, increased sensation.

HYPERMETROPIA, farsightedness.

HYPNOTICS, remedies to cause sleep.

ILEUM, lower part of small intestine.

INCISION, cutting.

INFECTION, giving of disease by germs.

INHALATION, breathing in.

INHIBIT, to restrain or govern.

INOCULATION, introducing into the blood.

INSOMNIA, sleeplessness.

INSPIRATION, breathing in.

INTERCOSTAL, between the ribs.

INTERMITTENT, coming on at intervals.

INTOXICATE, to poison the brain.

INTUITION, knowing without learning.

INVOLUNTARY, without action of will.

IRIS, the curtain of the eyeball.

ISOLATION, put alone.

KOUMISS, a fermented milk.

LABYRINTH, internal ear.

LACHRYMAL, tears.

LACTEAL, vessel carrying chyle.

LACTOSE, milk sugar.

LANCINATING, stabbing.

LARYNX, voice organ.

LEGUMINOSA, vegetable seed.

LEUCOCYTES, white blood corpuscles.

LEUCOCYTOSIS, excess of white blood corpuscles.

LYMPH, the nutritive fluid of the body.

LYMPHATIC, system of vessels for lymph.

MALIGNANT, violent and severe.

MASTICATION, grinding by the mouth.

MEATUS, opening (ear).

MEIBOMIAN, glands at edge of eyelids.

MENINGES, covering membranes of brain and spinal cord.

MENSURATION, measuring.

METABOLISM, change of body material.

MICROCOCCI, round bacteria.

MICROSCOPICAL, too small to be seen with the naked eye.

MIGRAINE, sick headache.

MITRAL, valve of left heart.

MOLLUSCS, shell-fish.

MORBID, diseased.

MOTOR, relating to motion.

MUCIN, in mucous secretion.
MUSCÆ VOLITANTES, moving spots before the eyes
MYOPIA, nearsightedness.

NARCOTICS, remedies to kill pain.
NARES, nose cavities.
NAUSEA, an inclination to vomit.
NECROSIS, death.
NEURITIS, inflammation of nerves.
NITROGENOUS, containing nitrogen.

OBJECTIVE, from without.
OBSTETRICAL, belonging to childbirth.
ŒSOPHAGUS, the gullet.
OLFACTION, sense of smell.
ORBIT, eye socket.
ORIFICE, an opening.
OS, a bone.
OSMOSIS, passing of fluid through a solid.
OSSEOUS, bony.

PALATABLE, to taste agreeable.
PARALYSIS, loss of function.
PARESIS, general paralysis.
PAROTID, gland secreting saliva.
PAROXYSMAL, in spells.
PASTEURIZE, to destroy disease germs by heat.
PASTILLES, aromatic substances used for burning.
PATELLA, knee cap.
PATHOGENIC, related to disease.
PELVIS, bony cavity of abdomen.
PEPSIN, the active principle of gastric juice.
PERCEPTION, consciousness of sensation.
PERCUSSION, sound produced by tapping.
PERICARDIUM, sac enclosing heart.
PERIPHERY, at the outside.
PERISTALSIS, worm-like movements of intestines.
PHAGYCYTOSIS, destruction of bacteria by leucocytes.
PHALANGES, fingers and toes.
PHOTOPSIA, flashing of light.
PHYSIOGNOMY, facial expression.
PIA MATER, covering of brain.
PIGMENT, coloring matter.
PLASMA, fluid part of blood.
PLEURA, lining membrane of chest.
PNEUMOGASTRIC, a nerve controlling the heart and respiration.
POSTERIOR, back part.
PRECIPITATE, to throw down.
PROCESS, projection, point.
PSYCHICAL, mental operations.
PTOSIS, drooping eyelids.
PTYALISM, salivation or constant flow of spit.
PUPIL, hole in the iris.
PURULENT, containing pus.
PYLORUS, intestinal opening of stomach.
PYREXIA, a fever.

RADIATION, sending out rays of light or heat.
RALES, rattling sounds.
REFLEX, to throw back.

RETINA, nerve lining of eyeball.
ROTARY, going round.
RUGÆ, folds.

SALIVA, secretion of the mouth.
SCHNEIDERIAN, membrane of the nose.
SCLEROSIS, hardening.
SCLEROTIC, outside coat of eye-ball.
SCORBUTUS, scurvy, a disease caused by poor diet.
SEBACEOUS, oily secretion of skin.
SENSORY, relating to sensation.
SERUM, watery secretion.
SOMNAMBULISM, sleep-walking.
SOPORIFICS, remedies to cause deep sleep.
SPASMODIC, in spasms.
SPHINCTER, muscle round an opening.
SPIRILLÆ, twisted bacteria.
SPLENIC, relating to the spleen.
SPORES, seed germs.
SPUTUM, spit.
STERTOROUS, deep, snoring breathing.
STERILIZATION, destruction of germs by heat.
STIMULUS, anything to increase activity.
STETHOSCOPE, to hear body sounds with.
STRIATED, striped.
SUBCUTANEOUS, underneath the skin.
SUBJECTIVE, from within.
SUDORIPAROUS, sweat and its glands.
SULCI, grooves.
SUPERFICIAL, near the surface.
SUPPURATION, forming of pus.
SYMPATHETIC, system of nerves of organic life.
SYMPTOM, a sign.
SYNCHRONOUS, at the same time.
SYNOVIAL, lubricating as a joint.
SYSTEMIC, throughout the body.
SYSTOLE, contraction of heart.

TACTION, tactile, touch.
TÆNIA, tape-worm.
TARSUS, bones of the ankle.
TEMPERATURE, degree of heat.
THEIN, the principle of tea.
THROMBUS, blood coagulation in a vessel.
TIBIA, large bone of the leg.
TINNITUS AURIUM, ringing in the ears.
TONIC, strong, rigid.
TRACHEA, windpipe.
TREMOR, trembling.
TRICHINIASIS, disease produced by pork.
TRICUSPID, valve of right heart.
TROPHIC, relating to life.
TUBERCULOSIS, a disease caused by tubercle bacilli.
TYMPANUM, ear drum.

UNCONSCIOUS CEREBRATION thinking unconsciously.
URETERS, channels from kidneys to bladder.
URETHRA, channel from bladder externally.

URINOMETER, instrument to weigh urine.

VACUUM, a space devoid of matter.

VASO-MOTOR, nerve control of blood-vessels.

VEGETARIANISM, exclusive use of vegetables for food.

VENTILATION, to change the air.

VENTRICLES, lower cavities of the heart.

VERMICULAR, worm-like.

VERTIGO, dizziness.

VESICLE, a small cavity or blister.

VESICULAR, a sighing sound.

VIBRATE, to flicker.

VILLI, mound-like projections.

VITAL, belonging to life.

VOLITION, will.

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